POWER

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The Mossback

By RUFUS T. STROHM

Jim Jimson worships all the past
And what his forbears did and said;
(He probably would stand aghast
If he were told that Lincoln's dead).
"The plant equipment father had
Was equal to the best," says he;
"If it was good enough for dad,
I guess it's good enough for me."

He views the stoker man with scorn
And draws the line at shaking grates.
No better engineers were born
Than were his ancestors, he states;
And as his grandad never saw
The chain grates or the underfeeds,
The old man's way is sacred law
Like that of Persians or of Medes.

He wheels his ashes to a dump,
Just like his great-grandfather did,
And feeds his boilers with a pump
His father tended when a kid.
No meters hang upon the wall,
Nor instruments of any kind;
There are no record sheets at all,
Because Jim Jimson goes it blind.

He thinks that he's conservative,
And scoffs at every modern way;
He doubts advice that salesmen give
And swears they merely talk for pay
"They all insist my plant is bad,
But that is largely bluff," says he;
"If it was good enough for dad,
I guess it's good enough for me."

Jim Jimson, poor, deluded dunce,
Forgets the world moves fast today;
The universe stood still but once,
When it was stopped by Josh-u-way;
And engineering progress speeds
With such increasing impetus
That plants which met our fathers' needs,
Are far from good enough for us.

Gasoline-Engine Drive for Centrifugal Pumps

Recent Applications of High-Speed Internal-Combustion Engines to Pumping Service as Stand-by, Emergency or Fire Units and for Isolated Pumping—Owing to the Numerous Advantages This Type of Unit Is Gaining in Popularity

By T. M. HEERMANS

As THE modern centrifugal pump is a relatively high-speed machine and the older types of gasoline engine operated at low and moderate speeds, it was necessary to introduce in the drive-gearing or similar devices. This was not a particularly desirable, quiet or economical arrangement, so until quite recently gasoline engines were used only for driving low-head slow-speed centrifugal pumps.

With the development of higher-speed gasoline engines in automobile work, and more particularly the heavier-duty high-speed engine used for tractor and marine service, the possibilities of using these engines directly connected to centrifugal pumps became more apparent. Furthermore, as these engines operated reliably at relatively high speeds, pumping units could be furnished for operating against high heads, so that the field of application was much broadened. Recently, a good many gasoline-engine-driven centrifugal pumping units have been furnished for different purposes. An idea of what these units are and what they can be used for may be of interest.

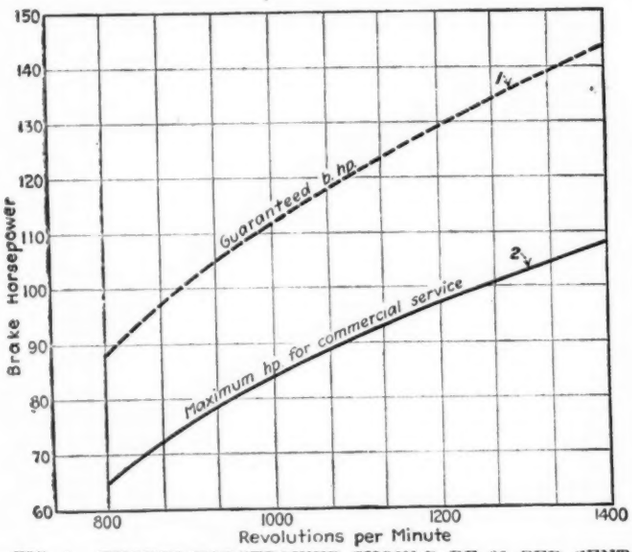


FIG. 1. ENGINE HORSEPOWER SHOULD BE 25 PER CENT GREATER THAN WATER HORSEPOWER

In general the units consist of a centrifugal pump, either single- or multi-stage, mounted on a baseplate with and directly connected to a high-speed gasoline engine by a flexible coupling. The engine is mounted on the same base with the pump. Except for the fuel tank, that is all there is to the complete pumping unit.

The engines are furnished complete with all accessories, including a governor, storage battery and electric starting equipment, so that it is necessary only to prime the pump and close the starting switch to place the unit in operation.

The maximum speed at which a gasoline-engine-driven pump should be run is usually about 1,200 r.p.m., although some gasoline engines are fully capable of operating dependably at higher speeds. Another point not to be overlooked is the nature of the service to which a gasoline engine is subjected in driving a centrifugal pump. This is full load steadily and not part load most of the time, as is the case with an automobile engine, which is run at full capacity only a small part of the time. For this reason, and also to allow for some pitting of the valves and slight lack of adjustment, it is advisable to install an engine whose capacity is about 25 per cent greater than the horsepower the pump requires. Data on this point, based on builders' tests, are presented in Fig. 1. Curve No. 1 shows the brake horsepower from a gasoline-engine builder's tests and curve No. 2 the maximum horsepower to be imposed on the engines driving pumps in commercial service.

Stand-by Units for Emergency and Fire Service

Applications for the gasoline-engine-driven centrifugal pump are numerous, but probably the most important are as stand-by units to be used in an emergency and for fire service. It is only necessary to recall numerous instances during the last few winters of coal shortages, difficulties of transportation, failure of electrical supply due to storms and other causes, to estimate the value of a stand-by unit not dependent upon an outside source of power. In city water-works it is common practice to install two identical pumping units, one for service and one for stand-by. Now if both are electrically driven, both are subject to the same inconveniences and both are liable to be out of service at the same time. On the other hand, if the reserve unit is a gasoline-engine-driven centrifugal pump, the protection is as good as possible. It is essential that the water supply to communities be dependable, and here is where a reliable stand-by unit comes in.

Concerning fire pumps, it is repeatedly admitted that if a good water supply at good pressure were quickly available without waiting for apparatus to get assembled, most fires could be put out at the start. A gasoline-engine-driven centrifugal fire pump provides just this protection. It has obvious advantages in isolated plants where electric service is not available or where it is inconvenient and expensive to keep a boiler in service winter and summer for fire protection.

Underwriter Boards Approve

A great many gasoline-engine-driven centrifugal fire pumps were sold during the war for fire protection in camps and cantonments, and as a matter of fact the Underwriter boards are recognizing the suitability of this practice for fire protection by drawing up approved specifications for this class of equipment.

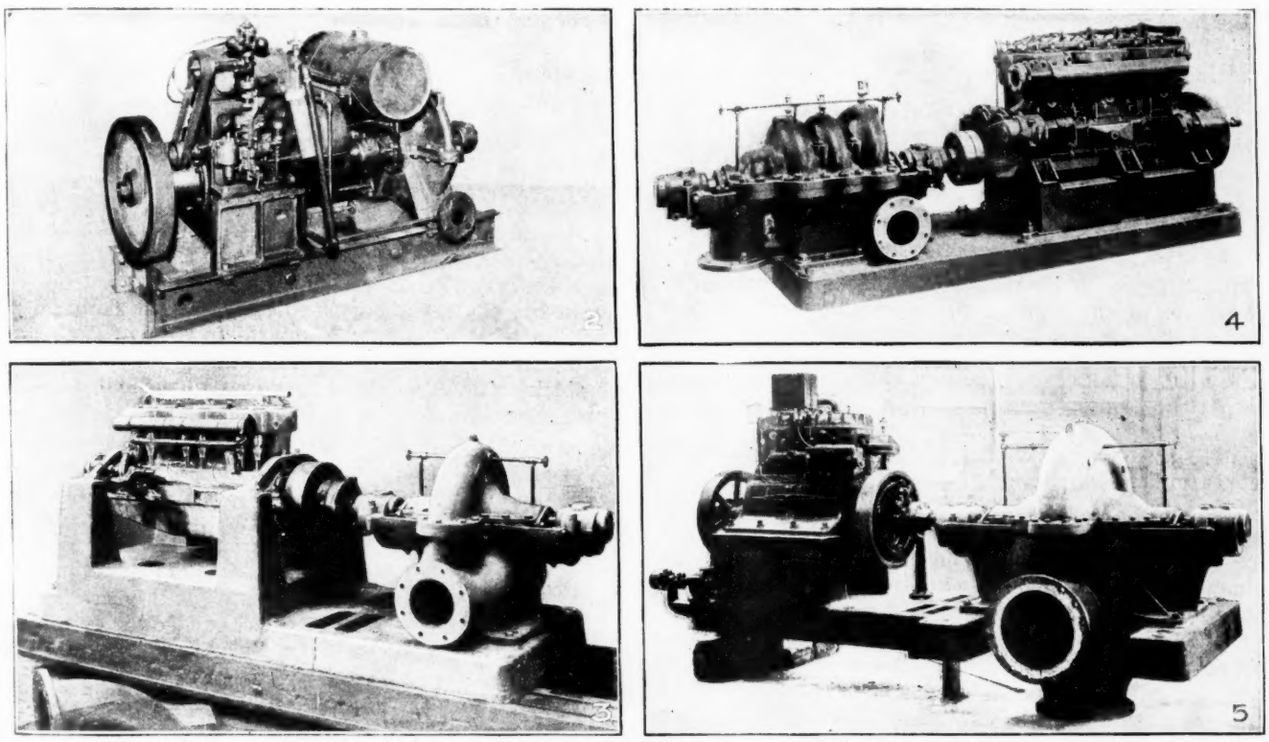
Other purposes for which the gasoline-engine-driven pump can be used are as portable pumps, in the smaller sizes, for pumping out cofferdams, manholes, etc.; drainage pumps which only operate a short time each year, as the extra cost of boilers or the connected load charge for motors during a period of idleness is saved;

driving pumps for sluicing operations in the removal of dirt and similar work where electric or steam power is not available.

Some of the advantages of this type of pumping unit are that they are self-contained units not dependent on an outside source of power. The engine operates at pump speeds, eliminating gears or other transmission devices. The amount of space occupied is small. Their operation is simple and readily understood by the average engineer, as they can be started up like a high-grade motor car and are ready practically instantly to assume full load. Furthermore, the cost of maintenance is low as no fuel is consumed while the units are standing idle, neither is there any connected load or readiness-to-serve charge for a motor which will be operated at infrequent intervals if the unit under consideration is in stand-by service. With steam pumps it is necessary to provide sufficient boiler capacity to operate the reserve and fire pumps, which means either oversize boilers or else an extra boiler for fire duty in which a required minimum steam pressure has to be maintained at all times. The gasoline-engine-driven pump does not need this extra initial investment or continuous ready-to-serve expense.

The gasoline-engine-driven centrifugal pumping unit makes it possible for towns and small cities to get better classification from the inspection departments of the Underwriter boards by providing reserve and emergency water supply. There are good high-grade gasoline engines that can be obtained for direct connection to centrifugal pumps in practically any size from 5 to 250 hp., so it is apparent that suitable units can be furnished for quite a range of pumping requirements. Referring to the illustrations, Fig. 2 shows a two-cylinder gasoline engine driving a 2-in. centrifugal pump rated at 100 gal. per min. against a 75-ft. head at 1,150 r.p.m. This type of unit is suitable for general stand-by water supply in small towns and villages, filling tanks or reservoirs for factory or mill water supply in isolated plants, small irrigation work, pumping out cofferdams or excavations, high-pressure street flushing, etc. Fig. 3 shows a four-stroke-cycle, three-cylinder engine connected to an 8-in. centrifugal pump having a capacity of 1,800 gal. per min. against a head of 85 ft. at a speed of 1,100 r.p.m. Such a unit is suitable as a stand-by for general service pumping.

In Fig. 4 is another type of high-speed gasoline engine driving a 6-in. three-stage pump designed to deliver 1,000 gal. per min. against a head of 231 ft. (100 lb. pressure) at a speed of 1,200 r.p.m. A considerable number of these units have been furnished for emergency fire protection. Fig. 5 shows a unit suitable for irrigation and drainage service. Here an 18-in. centrifugal pump capable of delivering 8,000 gal. per min. against a head of 15 ft. at 600 r.p.m. is connected through a clutch coupling to a 45-hp. kerosene engine.



FIGS. 2 TO 5. VARIOUS TYPES OF INTERNAL-COMBUSTION ENGINES USED TO DRIVE CENTRIFUGAL PUMPS

Fig. 2—Small unit suitable for stand-by water supply in villages and a variety of isolated pumping service. Fig. 3—Unit for stand-by general service pumping. Fig. 4—Numerous units of this type used for emergency fire protection. Fig. 5—This type of unit suitable for irrigation and drainage service.

When cleaning fires, wait for a light load, if possible; have plenty of water, a high steam pressure, and coal ready; clean one side of the grate at a time. At least once each shift blow out each blowoff valve by turning it slowly until wide open, and then slowly close it. This is done when the water circulation is slow and the sediment has settled. Next, the fires are cleaned. Then blow the tubes free of soot. Be certain that the blower pipes are drained out first and that the draft is on full. If the soot is blown off before the fires are cleaned, the tubes will become dirty again.

Voltmeters Affected by Line Inductance

By Victor H. Todd

When a voltmeter is located a considerable distance from the point at which it is desired to know the correct voltage an appreciable inductance in the lines between the instrument and the point of measurement may affect the indication. The question then arises, What error is caused in the meter's reading? The error depends on the principle of operation of the voltmeter and the frequency of the circuit. The dynamometer type is the least affected, the induction type is affected only slightly more, while the error in the moving iron-vane type may be considerably greater. In these three principles inductance will tend to lower the reading; but in the static voltmeter the inductance may cause an increased reading.

The effect on a dynamometer type is easily calculated by determining the increased impedance. For instance, if the meter has a resistance of 2,000 ohms and there is an inductance of 1 henry inserted in series, then the total impedance will be

$$Impedance = \sqrt{R^2 + (2\pi nL)^2}$$

in which R = resistance of meter in ohms, $\pi = 3.1416$, n = frequency in cycles per second, and L = inductance in henrys. Solving this for a 60-cycle circuit gives, $Impedance = \sqrt{2{,}000^2 + (2 \times 3.1416 \times 60 \times 1)} =$ 2,035 ohms.

The deflection, however, is inversely proportional to the square of the resistance; so, calling the deflection 100 per cent, we get the proportion $(2{,}000)^2 : (2{,}035)^2 = X : 100$

$$X = \frac{2{,}000^2 \times 100}{2{,}035^2} = 96 \text{ per cent}$$

This shows that an inductance of 1 henry causes the meter to read 4 per cent low in this particular case.

Where the instrument itself has appreciable inductance, as in the induction type, the moving iron-vane type and some forms of dynamometer-type meters, the inductance of the meter must be added to the inductance of the line to get the total value of L which is to be used in the foregoing formula.

It would be an exceedingly rare case to encounter enough line inductance in the primary of the voltage transformer to affect the secondary reading, but should such a case be encountered the total impedance of the transformer with secondary load must be calculated with and without the line inductance to get the correct results.

It might be pointed out that one henry inductance in voltmeter leads is a very high value. It would be encountered only in cases where the voltmeter is, say, several miles from the point of application, as, for instance, an automatic substation controlled from a main station or a voltmeter connected to a point of distribution. This was a familiar case before line drop compensators were introduced. The writer has never heard of a commercial case where the induction in the leads between voltmeter and its point of application caused an error in an industrial-plant voltmeter

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The coal production in Hungary is at present 19,000 tons a day, compared with 9,000 tons during the régime of the Hungarian Soviet government. The country's own requirements are eight million tons per year.

Chimney Felling Reduced to a Science

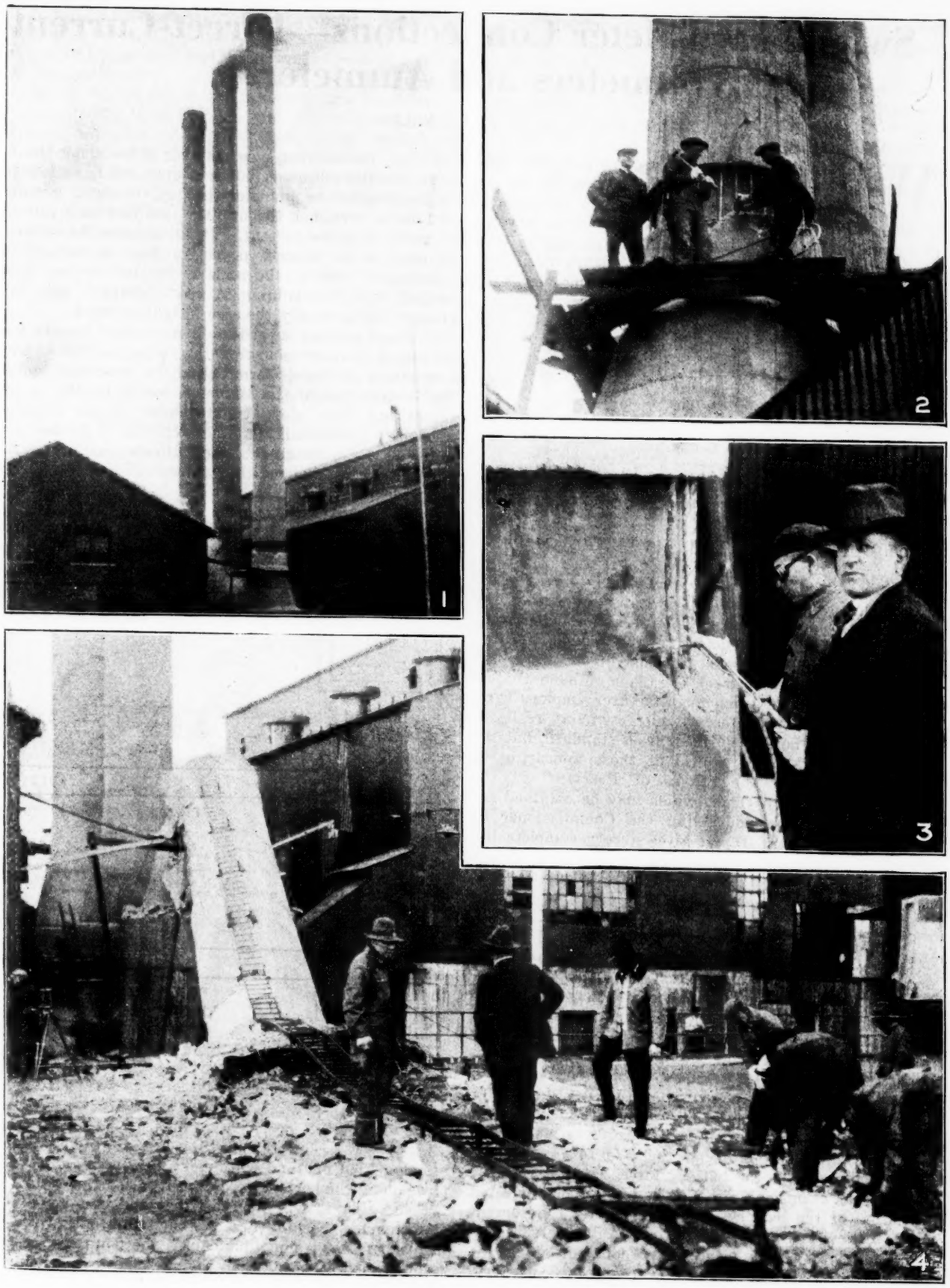
Owing to the rapid corrosion of self-supporting steel stacks and later to difficulties arising from unequal expansion when these steel stacks were surrounded by concrete shells, the Walworth Manufacturing Co., of Kewanee, Ill., has had recently some novel and expensive engineering experience. Originally, this company had four self-supporting steel stacks rising 165 ft. above the base and 6 ft. in diameter at the top. After three and one-half years of service the stacks had corroded to such an extent that it was necessary to take some action. A contract was let to surround the steel stacks with a concrete shell, 6 in. thick for the lower half and 5 in. thick throughout the upper portion. The concrete was heavily reinforced with vertical and horizontal rods from ⅝ to ¾ in. in diameter and with wire mesh.

Unfortunately, the builders did not take into consideration the difference in expansion between the steel in the old stack and the surrounding coating of concrete. Because of the greater expansion of the steel, the concrete soon started to crack, even when the boiler plant was operating at ordinary ratings and with the usual coal. When coal became scarce during the war, oil burners were installed, and as the load was unusually heavy, it was necessary to force the boilers. Stack temperatures got so high that flame appeared at the top of one of the stacks. The steelwork became red hot and weakened to such an extent that the stack tilted until it was 4 ft. 8 in. out of the perpendicular. In this bending part of the concrete shell broke away. One of the engineers happened to notice the dangerous condition of the stack and immediately turned off the fuel on the boilers it was serving. After the shut-down the stack returned about a foot toward normal, taking a permanent set 3 ft. 6 in. out of plumb.

There was nothing to do but take down the stack immediately, and at the same time a contract was let to fell the other three stacks later on. The first stack had to be taken down in six 25-ft. pieces, which were dropped in a space 30 ft. square between the railway tracks and the power house. Each piece, weighing about 35 tons, was dropped into the allotted space.

The outside stack at the opposite end of the row was the next to be taken down. Space was available to drop this stack in nearly its entire length, the cut being made 25 ft. above the ground to avoid damaging a stairway and pipe tunnels near the base of the stack. Fig. 1 shows the work under way. A cut through the concrete has been made around the shell. In Fig. 2 the workmen are chipping off the concrete. The reinforcing rods were burned off with an acetylene torch, and Fig. 3 shows the workmen ready to start burning the steel shell of the original stack. Fig. 4 is an illustration of the stack after it had been felled. Including the base the entire stack weighed 300 tons. The dropping was so skillfully done that there was no damage to the stairway or pipe tunnels previously mentioned.

With the two end stacks out of commission, the two middle ones are serving the boilers until two radial brick stacks can be erected in the place of those removed. It will then be necessary to throw the two middle stacks in a restricted space between the new stacks and the buildings, the clearance on either side being not much over six inches. These stacks will be replaced so that eventually there will be four new brick stacks serving the boiler house. This entire work was let to Peter Drolshagen, chimney expert, of Chicago.



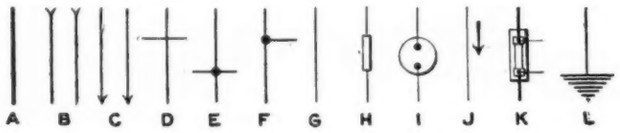
FIGS. 1 TO 4. SHOWING STAGES AND METHOD EMPLOYED IN FELLING THE CHIMNEY

Fig. 1—Operations under way to drop the second stack. Fig. 2—Evening up the cuts through the concrete. Fig. 3—Burning the reinforcing rods and the steel shell of the original stack. Fig. 4—View of the stack after it had fallen.

Switchboard-Meter Connections—Direct-Current Voltmeters and Ammeters

By E. A. REINMAN

WHEN electrical instruments are received, they are almost invariably accompanied by an instruction card which gives specific and general details regarding the instrument, and generally several diagrams showing how the instrument should be connected to indicate correctly. These cards are often torn off and destroyed by uninformed receiving clerks or



A-Mainline Conductor
B-From Source or Generator
C-To Load
D-Cross Between Wires (No Elec. Conn.)
E-Electrical Connection
F-Joint Connection
G-Meter Wiring
H-Fuse
I-Non Inductive Resistor
J-Direction of Current Flow
K-Shunt
L-Ground Connection

FIG. 1. TYPICAL SYMBOLS FOR METER WIRING

otherwise mislaid and consequently may never reach those persons to whom the work of connecting the instruments is assigned. The receiving-department employees should be instructed that the instruction cards or blueprints that accompany the instrument are a part of the instrument and must not be taken off or mutilated.

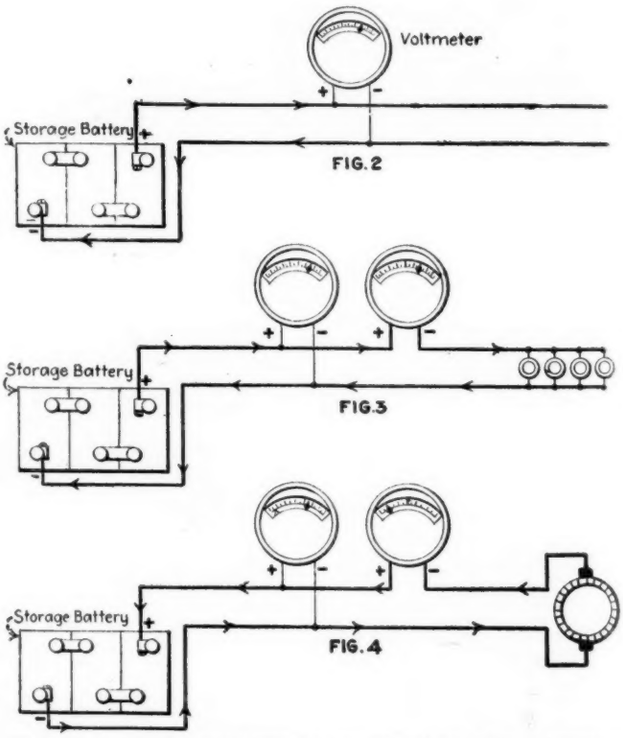
On these diagrams each manufacturer employs symbols to represent main feeders, meter wiring, resistors and so forth. There is no recognized standard, but the symbols in Fig. 1 are typical of those appearing in wiring diagrams. The "Rules of Practice" in the United States Patent Office, which may be obtained for 25 cents (coin) by addressing the Commissioner of Patents, Washington, D. C., gives a very complete list of symbols which must be followed in making drawings for patents, and these symbols are largely used by the various instrument manufacturers.

Battery Charging Panel

Perhaps the first panel that the average electrician encounters is the storage-battery charging panel containing a voltmeter and an ammeter with the necessary field resistors. When these instruments are installed, they will be found to have one terminal marked + or "plus" or "positive," terms that are identical and synonymous, and the other terminal —, "minus" or "negative." This means that when current enters the + terminal of the meter and leaves by the — terminal, the pointer will deflect in the proper direction, almost invariably from left to right. The problem, then, is to connect the instruments so that the battery forces current into the + terminal. Consider Fig. 2. The top wire is connected to the + of the battery, and consequently the current tends to flow out along the top wire; it enters the + terminal, flows through the meter coil, out at the — terminal and back into the — terminal of the battery. The small arrows show the direction of the current.

Now consider Fig. 3. We have connected a load to the battery and also connected an ammeter in the circuit. The current now not only flows along the top wire into the voltmeter, but continues and flows into the + terminal of the ammeter through the meter winding, out the — terminal, through the load and back into the — terminal of the battery. This will cause the ammeter to read or to indicate properly; that is, toward the "discharge" side of the scale if the instrument is arranged with the pointer to read "charge" and "discharge," as is usually the case in battery work.

In Fig. 4 we have substituted a generator for the load in Fig. 3, and are charging the battery. The current now starts at the + terminal of the generator, enters the — terminal of the ammeter, leaves by the + terminal and flows along the top wire in the direction shown by arrowheads. At the voltmeter it divides, part entering the + terminal of the voltmeter and part entering the + terminal of the battery. From the — terminals of battery and voltmeter the current unites and flows along the bottom wire back into the generator.



FIGS. 2 TO 4. INSTRUMENT CONNECTIONS FOR BATTERY CIRCUITS

Fig. 2—Measuring voltage only. Fig. 3—Measuring voltage and current, battery discharging. Fig. 4—Measuring voltage and current, battery charging.

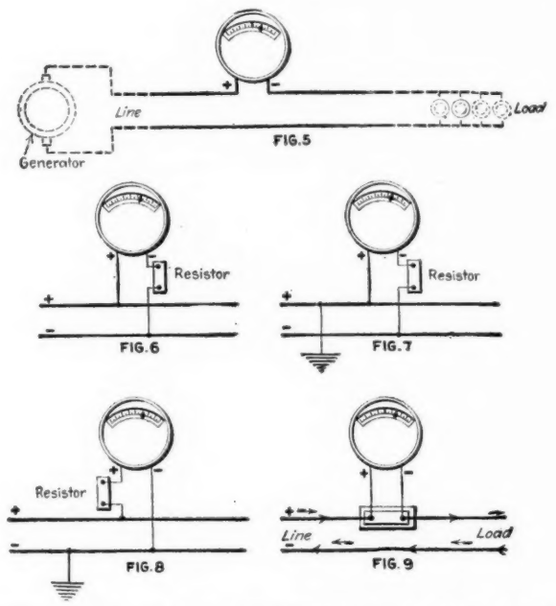
From this it will be seen that the current in the ammeter has been reversed; that is, it enters the — instead of the + and thus causes the pointer to give a reversed deflection, or read to the "charge" side of the scale. But it will be noticed that the polarity of the voltmeter does not change, whether the current is flowing from battery to load or from generator to battery.

It will be noted in tracing the current in Figs. 3 and 4 that in the first we started tracing the current from the + of the battery and in the second case from the + of the generator. As the battery was the source of power in Fig. 3 and as the generator was the source of power in Fig. 4, it leads to the first important rule in tracing out wiring diagrams; always start tracing from the + terminal of the source of power and end at the — terminal of the source; or if the source be a complicated diagram, follow through the source until the + terminal is again reached.

In the diagrams that accompany ordinary voltmeters, the generator and battery are usually omitted, it being understood that the voltmeter is to be connected "in parallel," "bridged" or "across" the lines. With ammeters, however, it is necessary to know the direction of power flow to get the correct reading, so ammeter diagrams take the form of Fig. 5 where the dotted lines are added to show how much of the diagram is supposed to be assumed, or understood to be already wired.

External Resistors and Shunts

As the voltage increases, the resistance in series with the voltmeter element must also increase, and as the power consumed varies with the square of the voltage, it is apparent that there soon comes a limit to the power that may be radiated in heat by the instrument case and still keep within a reasonable temperature rise. With large meters about 7 or 9 in. in diameter, the resistance for 750 volts may be safely inserted in the meter case; for a 3- or 4-in. meter the limit is about



FIGS. 5 TO 9. STANDARD AMMETER AND VOLTMETER CONNECTIONS

Fig. 5—Ammeter without shunt. Fig. 6—Voltmeter with a resistor. Fig. 7—Voltmeter, with positive side of line grounded. Fig. 8—Voltmeter, with negative side of line grounded. Fig. 9—Ammeter with shunt.

300 volts, while for a 2-in. diameter case the limit is about 50 volts. Above these values the extra resistance required is usually placed in separate metal-screened boxes on the rear of the switchboard panel or in other convenient location. External resistors should always be connected in series with the voltmeter, and care must be taken that a resistor is selected having the same serial number as the instrument to which it is connected. Fig. 6 shows the connection with an external resistor.

If the circuit is fully insulated, the resistor may be connected to either the + or the — terminal, regardless of an unfounded general opinion that the resistor should be in the + side. But when one side of the circuit is grounded, as in the case of a trolley system, one side

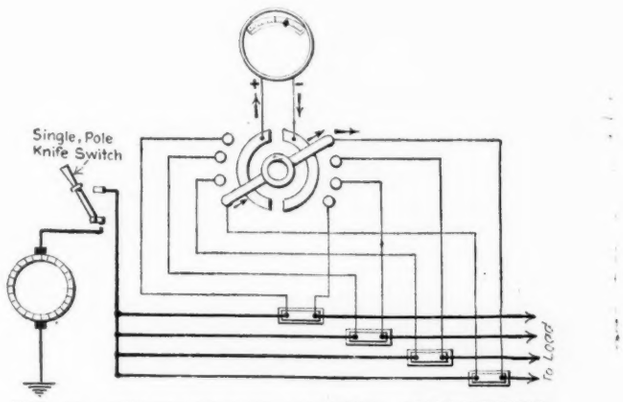


FIG. 10. MULTI-CIRCUIT AMMETER CONNECTIONS

of the meter should always be connected to the ground and the resistor connected in the ungrounded side. Fig. 7 shows a circuit having the + side grounded, and Fig. 8 a circuit having the — side grounded, with corresponding connections of voltmeter and resistor.

In an ammeter of the moving iron-vane type, the main current always passes directly through the instrument winding, and various capacities are obtained by using a large number of turns of wire for small currents, the number of turns decreasing and the size of wire increasing until for heavy currents the winding may be a single turn of heavy copper strap. The product of amperes and turns or ampere-turns in any type of instrument is practically the same regardless of capacity.

With an instrument of the D'Arsonval type, however, only a few milliamperes is required to operate the meter and the main current passes through a fixed resistor called a shunt. This shunt usually has enough resistance so that the voltage drop (that is, the product of ohms and amperes) is 0.050, 0.075 or 0.100 volt depending on the type and the maker. If an ammeter takes a shunt, the instruction card that accompanies it states this very clearly, therefore the meter installer should be careful to consult the instruction card. Perhaps as many meters are burned out by installing without shunts as by overload.

Fig. 9 is a diagram of an ammeter connected with a shunt. It will be noticed that the shunt merely forms a bypath for the excess current and does not disturb the polarity in any way. Meters of this type are always accompanied by special leads, generally 6 or 8 ft. long, provided with special clips for connecting to the meter terminals and shunts, and these leads should be used intact without cutting or splicing. If too long, the excess should be folded neatly (not coiled) and taped.

Ammeters may be placed in either wire of a circuit, but when a grounded circuit is used, the meters should be connected in the grounded side if possible. In such systems as grounded trolley circuits, where one generator supplies several feeders, this is impossible, as the circuits have a common ground connection and the

ammeters must be placed in the ungrounded circuits to indicate individual feeder currents. The best protection is to ground the case. In series arc-lamp circuits special ammeters are generally used with the insulation between the case and live element standing a very high potential test.

Instrument Switches

Oftentimes the expense of an ammeter or voltmeter is too great to warrant placing one on each individual circuit, and in this case an ammeter or voltmeter switch may be utilized. With this an interchangeable shunt is connected in each circuit and the leads led to the multi-contact switch as in Fig. 10. The ammeter terminals are led to the two moving contacts. By rotating the switch handle the ammeter may be connected to any shunt. The shunts need not be of the same capacity so long as the drop is the same, but in this case each switch position would be marked with a certain multiplying number. Care must be taken that the contacts are kept clean, or inaccurate readings will result.

When there are only two circuits to be measured, a double-pole double-throw knife switch may be used with connections as in Fig. 11. Here also great care must be taken to avoid contact resistance.

Voltmeters are usually changed to various circuits by means of plug holes and a plug. As shown in Fig. 12 the voltmeter may be connected to any circuit simply by inserting the plug in the desired holes. On small panels, where there are only two circuits, the double-pole double-throw transfer switch may be used to advantage.

Wiring in Conduit

In checking out complicated diagrams where the wires run in conduit, the use of colors forms a most convenient way of identification; certain circuits may be drawn with certain colored crayon and the wires obtained with various colored insulations or colored threads woven into the insulation, or the wires may be tagged with colored tags or with identifying letters or numbers.

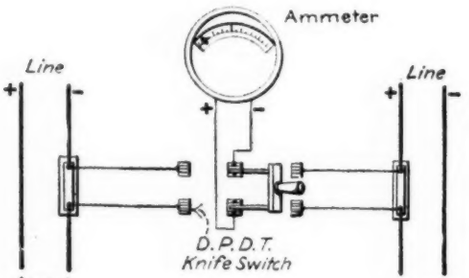


FIG. 11. DOUBLE-CIRCUIT AMMETER CONNECTIONS

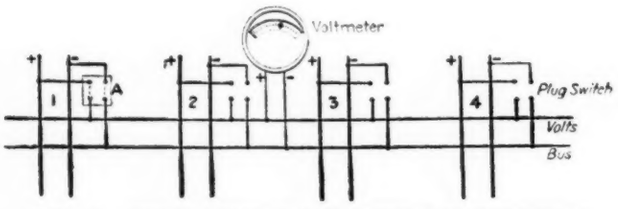
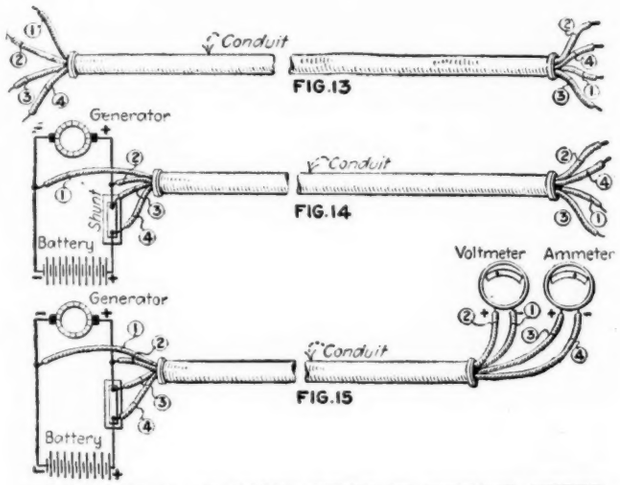


FIG. 12. MULTI-CIRCUIT VOLTMETER CONNECTIONS

As a typical example, let us consider an installation where the battery is being charged by a generator in the engine room, and that there are two instruments, an ammeter and a voltmeter, in the manager's office, with the connecting wires run in conduit. The first step is to measure the distance from the shunt to the meter location and order the meter "to be calibrated with leads of that length." When received, these leads and two potential wires are drawn into the conduit and then are rung out with a magneto as follows: One wire is tagged No. 1 and grounded temporarily. Then at the other end of the conduit one side of the magneto is grounded and the lead picked out which gives a ring on the magneto; this is also tagged 1. No. 1 lead is then disconnected at the opposite end and another lead grounded and tagged No. 2. This is picked out at the other end and tagged No. 2. The other two leads may be picked out and tagged 3 and 4 at both ends. The conduit and wires now appear like Fig. 13.

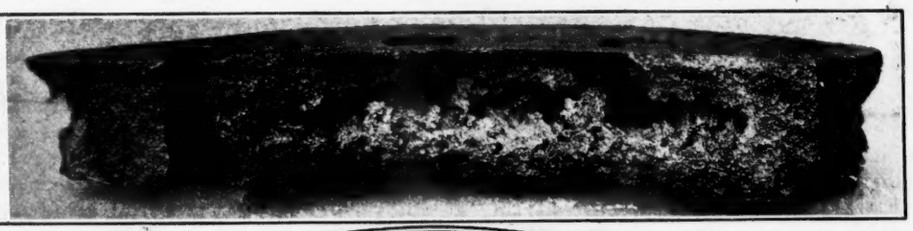


FIGS. 13 TO 15. VARIOUS STEPS IN TESTING METER WIRING AND MAKING CONNECTIONS

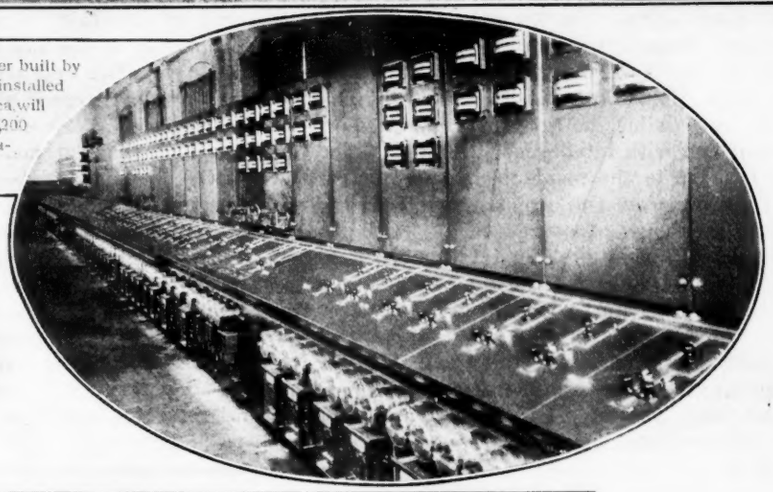
One end of the leads may now be connected to the line, as in Fig. 14. It will then be readily apparent that the potential enters No. 2 wire, and therefore No. 2 at the opposite end must be connected to the "plus" of the voltmeter; No. 1 lead is the + lead of the voltage circuit. The diagram also shows that the current enters No. 3 lead, and therefore No. 3 must be connected to the + of the ammeter. There is left only No. 4 lead, which must be connected to the negative side of the ammeter and serve as a return conductor for the current. Fig. 15 shows the completed diagram.

In this way very complicated wirings may be followed out with confidence that when the current is turned on they will conduct the currents properly and will not result in the burning up of instruments or the blowing out of fuses.

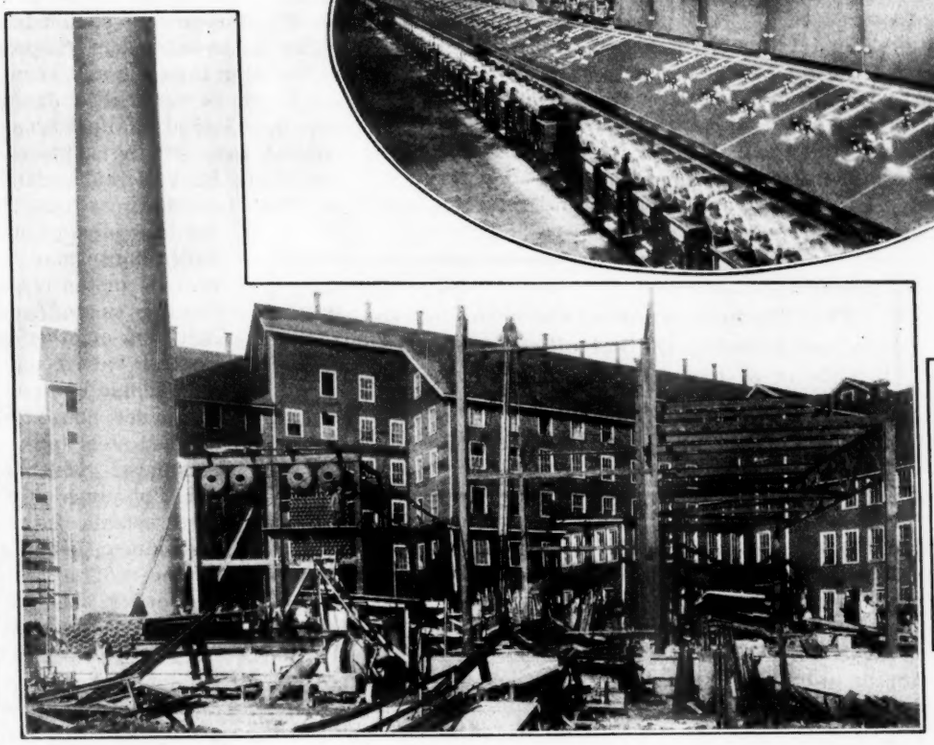
The use of oil is to provide a thin film between moving parts and prevent friction, anything in excess of this being wasted. At the same time it is not often that an exact amount can be supplied, but assuming that an oil of the proper heaviness for the particular part is used, no excessive waste need exist. Either oil feeders or cups should be provided to give a regular feed, or oil should be applied at regular intervals as needed in some other way, but in all cases the oil should be put where it is wanted only, and not be indiscriminately distributed over the whole machine.



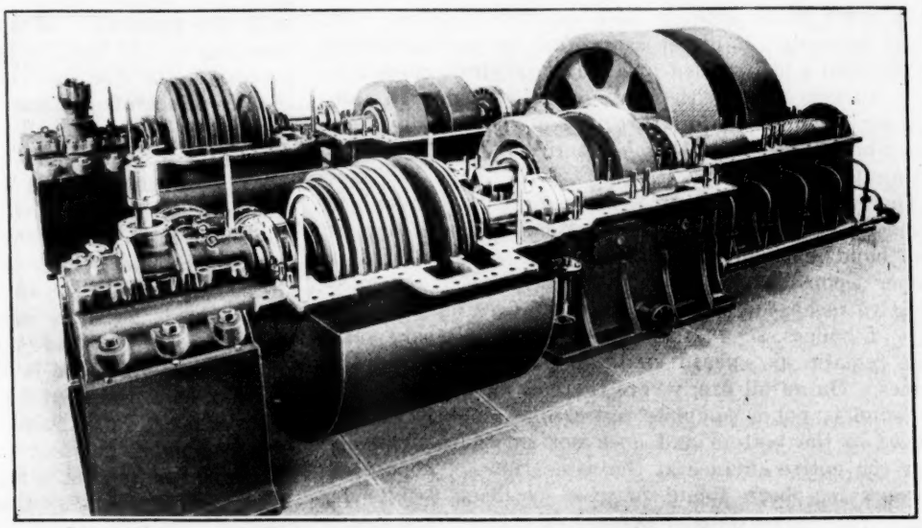
The dangerous blow-hole disclosed when this piece of steam pipe flange was broken up was never suspected during its years of use in the 59th St. Powerhouse of the Interborough Rapid Transit Co.



One of the largest switchboards ever built by the General Electric Co. It is to be installed in the City of Capetown, South Africa, will control two circuits of 11,000 and 2200 volts, and will ultimately have a capacity of 30,000 kw.



These two 5000 sq.ft. heating surface boilers were set up and bricked in before the power-plant was erected, because of lack of space and difficulty in getting structural steel on time. The plant was built for the Surpass Leather Co., Gloversville, N.Y., by Walter Kidde & Co., New York.



High- and low-pressure DeLaval marine turbines connected to a single propeller shaft through double-reduction gearing. This installation is one of five designed for the tankers of a large oil company.

Efficient Handling of Fuel Oil—1X

By ALLEN F. BREWER

IN THE modern fuel-oil burning plant there is no factor of greater importance to all concerned than the precautions and protections in force against fire. The actual danger of fire occurring, under proper care and operation, is perhaps less with oil than with any other fuel, owing to the absence of the possibility of spontaneous combustion. On the other hand, there is ever a lurking hazard waiting for an opportunity, afforded by carelessness, to flash into a disastrous flame. We must, therefore, guard against this hazard as effectively as possible, both with proper fire-protection equipment and with intelligent care in the handling of the oil. It is up to the plant officials to furnish the former, but nobody but the fireman can furnish the latter and most essential feature—care. With proper care the plant will have practically no need for fire equipment; it simply develops into a part of the equipment necessary to meet an emergency that should never occur.

In order that the fireman may fully realize the truth in the foregoing statement and the extent to which the safety of the plant depends on his caution and intelligence in the handling of the fuel, he must know the reasons why. To gain a clear idea of this without the more technical details, he should refer to the previous article of this series, which relates to storage.[1] In addition to thoroughly learning the reason for care, etc., he should know how to use properly the fire protection apparatus at hand, in the most effective manner, should fire ever occur. Misdirected effort is frequently the cause of a far more disastrous fire than necessary, which could have been checked at the beginning had the men kept their heads and made every ounce of water, steam or sand do its part in extinguishing the fire.

This, the final article of the series on the efficient burning of fuel oil, is confined to the subject of fire protection. In it are pointed out the methods and apparatus that are employed in meeting a fire emergency promptly.

General Types of Equipment

In order to be able to meet and check a fire emergency promptly, it is necessary that proper equipment be supplied and installed in handy localities. Such may be: Buckets filled with sand; buckets filled with sawdust or sawdust-soda mixture; steam smothering lines; water-hose lines; hand chemical extinguishers, and foam extinguishers.

The small boiler plant will generally be limited to the sand bucket, water-hose line, and perhaps one or two hand extinguishers. The sand bucket, with a proper scoop for spreading the sand, is one of the most effective means of protection against fires on the floor, tops of boilers, or in fact on any surface where sand will remain as spread and completely smother the flames. On an oil fire, where there is any depth to the oil, sand is not a complete protection, since it rapidly settles to the bottom and does not smother effectively over the entire surface at the same time. The use of sawdust has been found to give excellent results in extinguishing small oil fires on the floor, etc., from spilled or leaked oil. The sawdust, floating on the burning fluid, smothers the flame by forming a so-called blanket to exclude the air.

A mixture of sawdust and sodium bicarbonate (soda) in proportions of about eight pounds of soda per cubic foot of sawdust seems to increase the extinguishing properties of the sawdust. Do not use sawdust in light oil fires. The first particles will sink before the entire surface is covered, and the smothering action will be incomplete. The value of adding the soda is shown by the fact that on heating it forms carbon-dioxide gas (CO_2), which in itself will exclude air and help to blanket the flames.

Using sawdust alone, the storage cans should be carefully watched for signs of spontaneous combustion. Allow no oil drippings to enter the cans and keep them covered at all times. There is very little danger of spontaneous combustion in a stored sawdust-soda mixture provided the exposed area of the containers is kept below three square feet. Fuel-oil tanks should be fitted at the top with steam smothering lines, in order that steam from the boiler house may be admitted instantly above the oil in case of fire from lightning or other cause. Control valves on such lines should be in or near the boiler house. With exposed steel tanks it is considered good practice and "playing safe" to admit steam into such tanks on the approach of a thunder storm, keeping the space between the oil surface and the roof of the tank filled with steam until the storm is over. It does not cost much, and particularly with a wood roof tank or one not fitted with explosion hatches it is a good, safe plan to follow out.

Water is in general not a suitable extinguishing agent for oil fires, since it does not mix with the oil, and being heavier, allows the burning oil to float on it, with the possibility of spreading the fire rather than checking it. If the fire is small and oil volume is not excessive, the fire may be finally extinguished by the cooling effect of an excessive volume of water thrown upon it. With large oil fires, however, water is much more of a fire spreader than a preventive.

The best advice to the fireman is to keep water away from any oil fire with which he may come in contact. For open fires on the floor, etc., sand is perhaps the best and cheapest thing to use, as already stated. For oil fires in tanks or inclosed buildings steam is an excellent extinguishing agent; the chief part that steam plays is to fill the space above the blaze and keep fresh air from reaching the latter.

Foam, as a means of fire extinguishing, is practically a new idea. In a large oil-storage installation it is without doubt the most effective agent known for oil fires. To what extent it may develop into a general fire-prevention system for the boiler house is difficult to foretell. At present, except in many large industrial

[1] *Power*, March 1, page 349.

or refinery plants where a complete foam installation is in use, this system is seldom found in straight boiler-house practice.

The principles of the foam idea will be of interest, whether we are called upon to use it or not. In brief, this method of fire extinguishing involves two chemical solutions, which, when brought into contact with each other, will form a thick foam, somewhat like soapsuds. This foam settles over the blazing oil, excludes free, fresh air, and quickly extinguishes the flame. The foam thus formed is composed of fairly thick, tough bubbles, which in turn are filled with a non-inflammable gas.

Clean the boiler house and yard thoroughly every day. Gather and destroy all rubbish and waste material. Waste cans should be kept covered on account of the danger of spontaneous combustion. Never hang clothing over fire buckets, extinguishers, etc., or place tools, planking or other material where they will have to be removed before the fire equipment can be used. Daily inspection of tanks, oil lines, etc., must be made, in order to discover leaks in proper time for correction.

A Refrigeration Plant Problem

By J. C. MORAN

THE owners of a packing house decided to broaden their field, and among the additional equipment installed were the usual rolls for chilling lard, in which brine at a temperature of about zero degrees is circulated. The owners did not believe in spending money for consulting engineers or advice in the design or construction of any part of their plant. They had rebuilt the plant several times as the business grew, and if one thing did not work properly they simply added something more to it or threw it out entirely. The power plant in particular was more or less a mess of apparatus of every size and description. They never paid a man any more money than they possibly could get away with and still keep the plant going. In the final run they generally paid more for service or equipment than if they had put competent men on the job in the first place and had the job done right.

The man in charge of the power plant at the time the additional equipment was going in knew just about enough to keep the machinery running; his main qualification was that he was willing to work for less wages than the average engineer. As for being able to figure the additional capacity in refrigerating and other equipment required for the new department, this was entirely beyond him. The owners solved the problem of the proper capacity of equipment quite easily by going to a friend of theirs in another city, who had a plant of about the same size, and finding out what capacity he required for this work. They then practically duplicated his installation and figured that they would have no trouble on this score.

The Owners Guessed Wrong

They guessed wrong, however, because when they started the lard refinery the lard rolls failed to produce either the required quantity or quality. Both the manufacturers of the equipment and the engineers were blamed for the trouble, and both did their best to make the equipment do business. But no matter what they did, they could never do better than about 40 per cent of the rated output of the apparatus.

About this time the chief engineer got a better job and the night man was promoted to the job of chief. He had been on the job only a week when the change took place, but he had kept his eyes open and, furthermore, he had studied quite thoroughly the fundamentals of refrigeration so that, in addition to considerable experience, he had learned to use his head.

The owners came to the conclusion that the ammonia compressor, which handled the brine cooler for the lard rolls, was too small, and on the same day that the new engineer took charge they brought down a machine salesman to look over the job and give his ideas about the trouble and suggest what in his opinion would be the proper machine capacity.

After the salesman had left, the new engineer rather pointedly asked one of the owners what the idea was of buying Christmas presents at this time of the year. This led to considerable argument, and finally the owner called the engineer's hand by offering him ten dollars a week raise if he could produce the desired results for less than they would have to spend for the additional machine capacity they had about decided to buy.

Changing Suction Pressures

There were five machines in the plant. Two machines, one a 25-ton and the other a 40-ton, took care of the freezers and other low-temperature work. These machines were having an easy time of it, running at a slow speed even when the coolers were heavily loaded, and were operated on a suction pressure of zero gage.

The other three machines operated on a suction pressure of about 12 to 15 lb. gage, and when the brine cooler for the lard rolls was added, it was impossible to keep some of the room temperatures down where they should be. Also, as mentioned before, they could not get the desired results from the lard-cooling equipment.

The first move of the new engineer was to make some changes in the suction connections so that all sharp freezers were carried on the 25-ton machine at a suction pressure of zero. The remainder of the freezers and one or two of the medium temperature rooms were then arranged to be operated together with the brine cooler, on a suction pressure of about 5 to 10 lb. The 40-ton machine that had been operating on the freezers and a 30-ton machine that had been operating with the other two 50-ton machines on the high-temperature system were then connected so as to handle this load. This left the meat-chill and holding rooms and the ice tank on the other two 50-ton machines which were to be operated at a suction pressure of 25 to 30 lb. This would enable every machine to be operated to the best advantage and give the highest possible suction pressure all around, which in turn increased the machine capacity about 30 per cent.

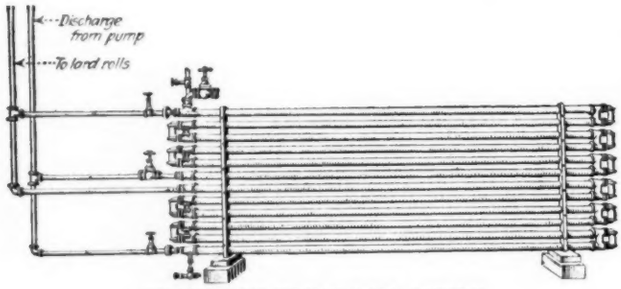
For the best results they required about zero brine temperature on the lard rolls. By operating the brine cooler on a system at 12 to 15 lb. suction pressure, with a corresponding temperature of zero to about 5 below, it was not possible to get the cooling effect out of the

brine cooler and keep the brine temperature down to zero, as the brine would then be nearly the same temperature as the ammonia. Reducing the suction pressure on the system on which the cooler operated to 5 to 10 lb. brought the ammonia temperature down to somewhere around 15 deg. below zero, and of course this lowered the brine temperature. Still the results were not so good as was desirable.

Unsuitable Circulation Pump

The next Sunday the engineer made a temporary connection from the brine connections of the brine cooler to one of the high-pressure house pumps in the engine room. Monday afternoon when the lard rolls were started the high-pressure pump was used as a circulating pump for the brine to the lard rolls, and after the brine feed valve was throttled things worked better.

The big joke, in addition to trying to operate a low-temperature apparatus like this brine cooler on a high-pressure system, was that they had originally a brine pump absolutely unsuited for the conditions. They had been informed by their friend who owned the other plant on which the owners based their estimates, that ten pounds pressure at the rolls would do the work. They happened to have in the plant at this time an extra centrifugal pump which was rated at a 50-ft. head or about 22 lb. pressure, and as it had the same size



CHANGE IN BRINE-COIL PIPING

inlet and outlet as the 2-in. piping to the brine cooler, they assumed that it would be ample for the work and hooked it up.

For the best results the temperature drop should not be over one to two degrees. This means a comparatively large volume of brine to be handled at a small temperature difference. Assuming roughly that about 25 gal. of brine must be circulated per ton per minute with a temperature difference of one degree or 12.5 gal. per minute with a temperature difference of two degrees, it would require at least 125 gal. per minute to produce the required ten tons capacity that the new department demanded when in full operation.

How the Cooler Was Made

The construction of the brine cooler is shown in the illustration. This was of the double-pipe type, one stand, 10 pipes high, 18 ft. long, 2-in. inside pipes and 3-in. outside pipes, and rated at about 12 tons, so that there was really some reserve capacity. The brine in these coolers circulates through the inside pipe, while the ammonia is contained in the space between the inner and outer pipes.

From the illustration it will be seen that the entire volume of brine handled by a single stand must pass through the 2-in. inside pipe. In order to maintain the required temperature difference of one to two degrees between the inlet and outlet from the rolls, approximately an average of 150 gal. per minute had to be passed through the brine cooler. The total length of pipe was about 10 × 18, or 180 ft. To this must be added nine return bends, which also require considerable power to force the brine through them at high velocity. To pass 150 gal. of brine through a 2-in. pipe per minute a velocity of about 850 ft. per minute is required, which, as anyone who has had anything to do with water-pumping systems knows, is some speed.

The friction head per foot of 2-in. pipe is about 0.5 ft. for a velocity of about 850 ft. per minute or for a discharge of 150 gal. in the same time. For 180 ft. it would be about 90 ft. The nine 2-in. return bends would require about 7 ft. per bend at this velocity, or 63 ft. for the nine bends. The total would be 153 ft., or roughly about 65 lb. required to force the brine through the cooler.

There was in addition about 80 ft. of 2-in. pipe in the discharge line and the same length of return, through which the brine would have to travel at the same velocity, and there were a number of ells in both the discharge and the return lines so that, considering the whole system, it would require at least 150 lb. pressure to keep the brine moving at the proper velocity. Furthermore, the engineer found upon closer investigation that the pump was running about 1,000 revolutions per minute instead of 1,200 as it was designed to do, a slower-speed motor having been connected to it in place of the one called for by the pump makers. It was impossible then to circulate the amount of brine actually required. The high-pressure house pump that was finally connected to it, had of course plenty of capacity, both as to pressure and volume and as a consequence they got the work out of the rolls that they had been designed to do.

Change in Brine Cooler

There is one advantage in circulating the brine at this high velocity through the brine cooler. A reasonable speed is about 300 ft. per minute and even as low as 250 in many installations. By more than doubling the speed the heat transfer per square foot of cooler surface is increased about 50 per cent, which increases the capacity that much more in case it is too small for the work. In this case, however, the cooler was plenty big enough, so the brine-circulating section was split in two, the brine passing through the cooler in two parallel sections, which required a slight change in the piping connection and the removal of one of the return bends in the center. This cut the velocity in two and the friction loss through the cooler in four. In other words the velocity was reduced to about 425 ft. per minute and the friction head to about 10 pounds.

For the discharge and return lines 3-in. piping was substituted for the 2-in., which reduced the friction head in the piping to about one-tenth of that for the 2-in. pipe, so that the friction loss in this part was probably not more than 6 or 7 pounds.

Finally, a change was made in motors so that the pump was operated at about 1,250 revolutions per minute, and after the changes were made no further trouble was encountered in operating the lard rolls. The engineer who had solved the problem got his raise, and when changes or additions were made to the refrigerating or power-plant equipment, and for that matter any of the mechanical equipment around the plant, he was always called in for advice, and generally was given his own way in the matter.

The Location of an Industrial Power Plant

By M. K. BRYAN and A. S. WELLS*

THE almost universal application of electric drive in industry makes it possible and usually advisable to centralize in one power house the production of steam and power for a factory, regardless of its present or ultimate size. This means that the power house, instead of being built as a lean-to at one end of the factory, hedged in on all sides, should be out in the open where it can be extended to meet the growth of the factory without encroaching on valuable manufacturing space. In other words, the location and design of every industrial power plant, whether boiler house, generating station or substation singly or combined, should be decided upon according to a definite power-plant policy for the possible development of all real estate in the property under consideration.

Such a statement seems so self-evident that one might think further discussion of it futile. However, experience in many detailed analyses of power-plant situations in different parts of the country has demonstrated that the design of an industrial property is too frequently executed without the proper appreciation of the power plant's function in the growth and development of the factory, or regard for the fundamental principles of location and design upon which will depend the practical and economical operation of the enterprise. The treatment of the power plant as a sort of necessary evil, to be tacked on somewhere or other after the design of the other buildings had been completed, has been prevalent. In many cases an efficient power plant will be constructed, which meets demands for a few years; but when it is outgrown, it is found to have no adequate provision for future expansion. Again, there are instances where several distinct power plants consisting of a boiler house, engines and operating force, are maintained in a single property, when a central generating station would supply all demands more efficiently.

The authors emphasize the importance of far-sighted planning for possible future development in the original design of an iudustrial establishment, particularly with respect to the site for the power house, and give four typical examples of plants in which the lack of such foresight was the cause of many troubles in operation and of costly modifications in plant and equipment.

There is one simple rule to be followed when planning industrial plants, which would often be the means of avoiding future trouble with the power situation. This rule may be stated as follows: Given a tract of land upon which a manufacturing plant is to be started or has been started, with one or more factory buildings requiring a steam plant and perhaps engines or generating equipment; even though plans for future extension of the factory may be exceedingly vague, cover the property map with manufacturing buildings of some sort and decide roughly how much steam and power would be required for a factory of that size. Then decide where to locate the power plant for these conditions, and nine times out of ten that will be found the correct location for the initial and final installation. However, it is not the purpose of this article to lay down a set of arbitrary rules as to where a power plant should be located, what machinery it should contain or how much expansion should be provided for, because, aside from a few fundamentals with which almost everyone should be familiar, each case presents its own special problems, the proper solution of which depends upon the application of sound and experienced judgment. It will not be out of order, however, to enumerate the following fundamental considerations in locating a power house:

1. The property should be utilized to the maximum advantage for manufacturing, and the land taken for the power-plant site should, if possible, be the least desirable for manufacturing purposes.
2. The site selected and the general arrangement of the plant should allow easy and practical expansion.
3. Railroad facilities for handling the coal and ashes and a water supply for condensing and feed purposes should be available or should be provided.
4. There should be ample space for fuel storage, so arranged that the process of storing and reclaiming can be easily carried out.
5. A central location on low lying ground is desirable if it does not conflict too seriously with the conditions under (1).

The relative importance of these fundamentals will vary with the individual cases under consideration, and particularly so when there are considerable amounts of process steam to be supplied; for in this case a central location for the power plant may be essential. Furthermore, the rapid development of electricity and its uses affords the opportunity of locating manufacturing plants most advantageously with reference to raw materials and to conditions necessary for the most efficient production. It is highly advisable to start industries whenever possible on navigable rivers, bays, sounds or harbors; if not on a navigable river, at least on a good-sized river with clean water, or under such conditions that the water may be cheaply filtered or treated. In other words, in the locating of any factory subject to future expansion it is very necessary that such a plant should be started at or near a good source of water supply. This insures a good supply of condensing water for the power plant, and in plants of any size more or less condensing water will be required, even with byproduct turbines. In the old days plants were located on streams where there were little waterfalls and from such locations evolved great industrial stations, many of which are now at a disadvantage in the competition for the world's trade.

The following examples taken from actual practice illustrate cases where power plants became inadequate, and describe the changes recommended to meet the situation.

Fig. 1 shows the property map of a plant in which further expansion was blocked on all sides, after two

*With John A. Stevens, Engineer, Lowell, Mass.

boilers and two small engine generator sets had been installed. The boiler plant was closely bounded in the front and rear respectively by the railroad tracks and a shop building and on the sides by a machine shop and a craneway. The space allotted for coal storage was also too small. The erection of a large new shop

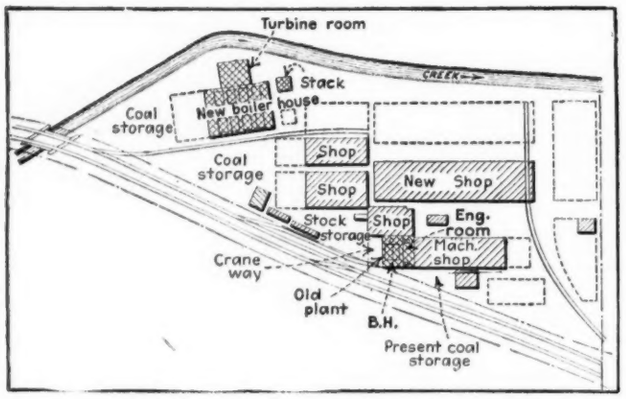


FIG. 1. SHOWING LACK OF SPACE FOR POWER PLANT EXPANSION

requiring additional boiler capacity has been planned, and this will demand a new boiler plant. The place occupied by the old power plant will be used as manufacturing space, for which it is better adapted by virtue of its location.

In choosing the new location the idea was to provide a plant that could be expanded according to a definite plan to meet future demands without encroaching on manufacturing space. It will be noticed that the site chosen fulfills this requirement. The bend in the creek is not in the direction of natural factory growth, but is nevertheless well suited to the boiler house. The turbine house, which in this particular instance will always be small compared with the boiler house, is near the condensing-water supply, and space has been allowed for a water-treatment plant for the boiler-feed water. Coal can be stored in the open along the railroad siding as well as in an overhead bunker in the boiler house. The boiler house, as shown, provides a capacity more than eight times as great as that of the old boiler plant and still greater expansion is obviously possible. At the start only two or perhaps four boilers will be installed in the new house, the others being added as demands for steam increase.

Fig. 2 shows a property composed of three large mill units, several scattered smaller units, a machine shop and many large warehouses. Each of the large mills, Nos. 1, 2 and 3, had its own complete power plant. Power for buildings in group *A* was obtained through a rope driven from mill No. 1. The repair shop had its own steam engine, but received steam from the boiler house at mill No. 1. The latter was driven by a tandem-compound condensing steam engine, taking steam from the adjacent boiler house. No. 2 also had a steam-engine drive with its own boiler house. All boilers in both plants were horizontal return-tubular type hand-fired. No. 3 was driven by a gas engine, the gas being supplied by a producer plant some 250 yards away from the engine, near the water front.

In this case the problem was not to provide for large and immediate expansion. The power plants at mills Nos. 1 and 2 were splendid examples of their type, and each in itself showed more than average efficiency. Obviously, however, the duplication of plant-operating forces and equipment was expensive. The engine in No. 1 was thirty years old and overloaded. No. 2 engine, while only fifteen years old and still apparently in good condition, had operated on practically continuous twenty-four hour service for ten years of its life and was also somewhat overloaded. The gas engine in No. 3, while the newest of the three units, had very poor speed regulation and was subject to frequent breakdowns which would shut down the entire mill for hours and even days at a time.

In view of the most unsatisfactory operating conditions an analysis was made of the plants and property to determine what changes seemed advisable. A definite policy of centralization and electrification was decided upon after comparing its practical advantages and earnings with the present plant and other proposed schemes. The first step was the installation of enough generating capacity to motorize mill No. 3 and the

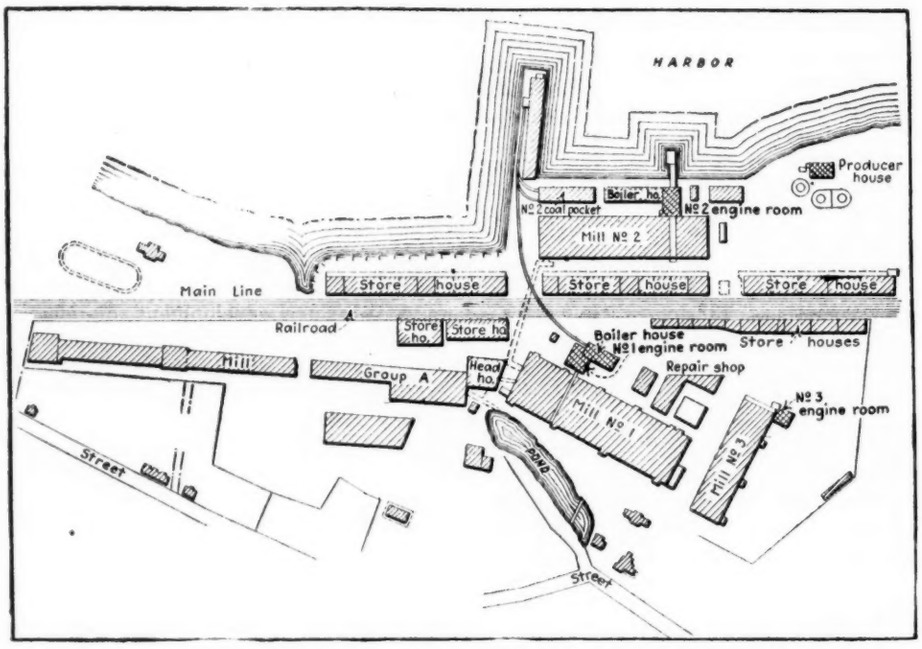


FIG. 2. SHOWING DISPERSION AND DUPLICATION OF POWER EQUIPMENT

machine shop and portions of the load in other mills. In mill No. 1, a number of motors were installed to reduce the engine load and also to allow efficient overtime operation of certain machines. In mill No. 2, a large air compressor was likewise motor-driven to reduce the engine load.

The obvious location for the new central station was on the water front, since coal came in by barge and an unlimited supply of cold sea water was available for condensing purposes. The engine and boiler houses at mill No. 2 were fortunately so located and con-

structed that, by comparatively simple changes, they afforded suitable space for new high-pressure water-tube boilers, turbines and condensers, sufficient for present and future needs. An intake and pumphouse for condensing water were constructed just outside the sea wall, and a channel dredged up to it from the main ship channel.

All motors were installed and changes in shafting and drives so planned that when the new generating equipment was ready for operation, motors could be put into service one by one, gradually taking over the load without interruption of service, until the gas engine was entirely unloaded and could be shut down.

A similar procedure will be followed in the other mills as conditions warrant, and ultimately the one plant at No. 2 mill will supply steam and power for the entire property.

Fig. 3 illustrates a type of plant that is not uncommon in small sizes. The natural line of growth for such a plant is for the boiler house and engine or turbine room to expand in opposite directions. This in itself is a weak point since space must be provided for this growth in two directions rather than in one only, as is the case where boiler house and turbine room grow side by side in the same direction.

In this particular property the plant itself was well built and up to its present capacity (three boilers and two engines) had proved to be entirely satisfactory and reasonably economical. Further expansion, however, is blocked on the one side by the brick stack and six-story manufacturing building and on the other side by the wood shop. Fortunately, the wood shop was a one-story frame structure and could be torn down to make way for extension in this direction. This, however, provides for expansion of the engine room only, and any extension of the boiler house would have to be through the present engine room, by displacing one or more units, a very objectionable solution. As a matter of fact, the three old boilers are of small capacity, of

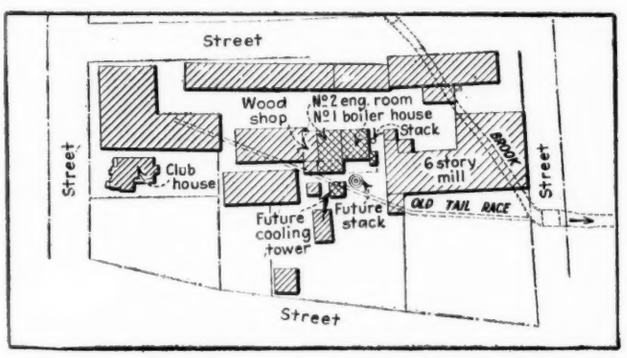


FIG. 3. SHOWING LACK OF EXPANSION SPACE

the horizontal return-tubular type, and after one new water-tube boiler of about 5,000 sq.ft. of heating surface has been installed, it will be possible to provide considerable further increase in capacity by replacing the three old boilers with two boilers of the same type and size as the new one, increasing the height of the boiler room to fit the new units. In this way, if expansion becomes absolutely necessary, the awkward situation can be met and all requirements fulfilled.

Fig. 4 is a mill property, where a central steam and power-generating station shows large savings over the existing arrangement of four boiler houses and numerous engines.

No. 5 boiler house is a comparatively new plant, yet obviously there is no opportunity for further expansion. It would seem that the location labeled new boiler house would have been a more logical one, as it

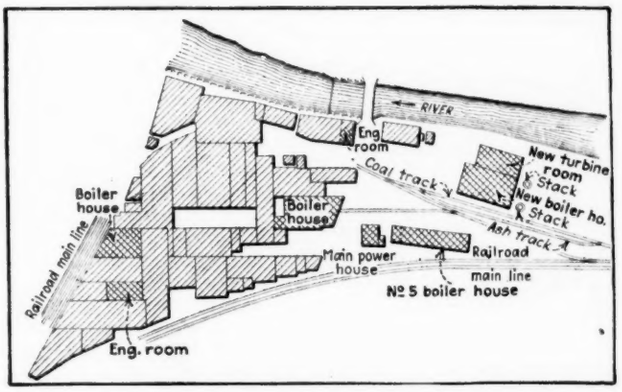


FIG. 4. SHOWING DISPERSION OF EQUIPMENT AND LACK OF EXPANSION SPACE

provides ample space for a boiler house and turbine station to carry the load for the entire present property, with space for future expansion. It is also conveniently situated for railroads and water and does not encroach on space more valuable for manufacturing buildings.

The foregoing examples have been cited not because they are unusual cases of good or bad power-plant policy, but because they are typical of many other cases with which all power-plant engineers come in contact in their everyday work.

Creeping of the Electrolyte in a Storage Battery

BY E. S. BAXTER

Attention was called to what seemed to be a cracked or leaky jar in a set of storage batteries. The faulty cell happened to be the first one on the positive end. No crack or any other spot that the electrolyte could leak through was visible. The sand around the jar was very damp, and the electrolyte low in quantity and in specific gravity, owing to the frequent addition of water to make up for the leakage.

A new jar was procured, and after testing it thoroughly for leaks and equalizing the electrolyte among all the jars in order to get correct specific gravity, the battery was given a charge. But this did not remedy matters; the electrolyte kept going down in the same jar and only in that one, and the sand around it was as moist as ever. Upon examining the cell closely, it was observed that the jar was wet all over the outside, and it was concluded that some form of creeping was taking place. So the plates were raised, thoroughly dried and the connecting strap cleaned, also the edge and outside of the jar; after which the connecting strap was covered with vaseline down to within one-half inch of the top of the electrolyte; and the leakage ceased.

It seems evident that the electrolyte by some means was being carried up over the plate terminals, and from there to the outside of the jar, by what seems to be a form of creeping or capillary action.

Friction and Fuel

How to Reduce the Consumption of Fuel by Reducing Friction—Conditions and Considerations Affecting the Choice of Lubricants—Physical Tests

By WILLIAM N. BERKELEY*

A WELL-KNOWN and standard work on lubrication and lubricants, in emphasizing the great power losses that result from the imperfect lubrication of machinery, makes the following very impressive statement: "One would not be far short of the mark in saying that from 40 to 80 per cent of the fuel used for power purposes is consumed in overcoming friction."[1]

It is evident from the foregoing that we use an enormous amount of fuel to overcome friction and that, consequently, in these days of extremely high cost of fuel the reduction of friction to the very lowest practicable minimum is more profitable than it has ever been before.

But minimum friction is possible only when the quality of the lubricant used to decrease it is that best adapted to the particular machine in which the friction occurs. In many cases the loss from using the wrong lubricant is as great as that which would result from using no lubricant at all, and this loss is sure to result unless we select the lubricant that is suited to the machine and to the conditions under which it operates.

In order to select the best lubricant for any particular use, we must know not only the conditions under which it is to be used, but also how these conditions affect the quality of the lubricant.

The following operating conditions must be known: The temperature to which the lubricated surfaces will be exposed; whether steam or water comes in contact with these; the pressure on the lubricated surfaces; their sliding or rotating speed.

Why the Temperatures Must Be Known

The only reason that we use lubricants at all is that their use enables us to substitute the comparatively slight friction between the particles of the lubricant for the usually much greater friction between the surfaces to be lubricated. Now the friction between the particles of the lubricant (internal friction) decreases rapidly as the temperature increases, but it does not decrease alike for all oils, so that the important things to know are: The operating temperature and which one of a number of oils is most affected by it.

If the oil that has the least internal friction has still "body" enough to keep apart the surfaces to be lubricated, this is the best oil to use provided its other properties are satisfactory. To test the internal friction, we test what is called the "viscosity" of the lubricant, a very simple test in experienced hands and an extremely valuable one when properly made at the right temperatures.

Why We Must Know Whether the Lubricant Is to Come in Contact with Steam or Water

Oils vary greatly in their tendency to "thicken up," or emulsify, as we say, when water or steam is mixed with them, especially if the two are churned together by violent agitation. Excepting in the cases of steam-cylinder and marine-engine oils, where this emulsifying prevents the washing off of the lubricant by the steam or water, an oil that tends to emulsify is undesirable for two reasons, chiefly: Because it is always difficult and sometimes impossible to maintain a regular "flow" of the oil to the surface to be lubricated; and because it is difficult, if not impossible, to recover the lubricant for repeated use.

For this reason, when it is known that the oil is to come in contact with water or steam, it is very important to select one that has the least tendency to emulsify, unless, as already explained, the lubricant is for use in a steam cylinder or marine engine. It is only very recently that this question of the emulsifying properties of oils has received the attention it deserves, and no doubt what might be called the de-emulsifying factor of an oil (expressed by stating the volume-percentage which settles out in a given time after having been emulsified under given standard conditions) will very soon be incorporated as a provision of specifications for lubricating oils.[2]

Why We Must Know the Pressure Between the Surfaces To Be Lubricated

It is evident that the greater the pressure (that is, the greater the tendency of the lubricated surfaces to come in actual contact) the greater must be the resistance offered by the lubricant to this squeezing-out process. If the pressure is very high, a grease must be used instead of an oil, especially in the case of slow-moving machinery. Pressures that occur in various bearings are about as follows:[3] (a) Slow-speed stationary engines, from a minimum of 80 lb. per sq.in. in the main bearing (dead load) to a maximum of 1,500 lb. in the crosshead pin bearings; (b) high-speed stationary engines, from a minimum of 60 to a maximum of 1,800 lb. in the same bearings; (c) merchant-marine engines—main engine bearings, 400-500 lb. per sq.in., main engine crankpin bearings, 400-500 lb. per sq.in.; (d) Naval vessels—main engine bearings, 275-400 lb. per sq.in.; main engine crankpin bearings, 400-500 lb.; steam turbine bearings, 85 lb.; thrust bearings, 50 lb.

Why We Must Know the Rotating or Sliding Speed

Where the lubricated surface moves at a high velocity, as, for instance, in the case of cotton-mill spindles, the lubricant must naturally offer a minimum resistance to this rapid movement, and in such cases, in which high speed and light pressure are almost always associated, a very light-bodied oil must be used. Average Shafting Speeds: Cotton and woolen mills, 300-400 r.p.m.; Machine shops, 125-175; Wood-working shops, 200-250.

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*Industrial Chemist, Baltimore, Md.

[1] "Lubrication and Lubricants," Archbutt & Deeley.

[2] A good deal of very creditable work in the way of devising emulsifying apparatus and in the determination of de-emulsibility factors of oils has been done already, notably at the United States Naval Engineering Experiment Station, Bureau of Standards, and doubtless in similar investigations elsewhere of which the writer is ignorant.

[3] "Lubricating Engineers Handbook," John Rome Battle.

Engineers consider that a knowledge of the speed of and pressure on bearings is indispensable to a wise selection of lubricants; indeed Battle states that it should be the "determining factor" in choosing a lubricant for any bearing. There are several important effects of increased speed which are frequently overlooked:

1. Beginning with direct contact while at rest, the journal and bearing under the influence of increasing speed tend to separate more and more from each other.
2. The more complete separation of the bearing surfaces reduces the friction between them.
3. The resulting greater interbearing space permits the entrance of a larger volume of lubricant so that both 2 and 3 tend to reduce friction. It is evident, therefore, that at high speeds a light-bodied oil is desirable, as its internal friction is less and the reduced pressure from increased speed will tend to prevent the oil from being squeezed out.

Within certain limits, then, increased speed promotes lubrication, especially where the pressure is light.

Some Very Useful and Less Useful Tests of Lubricants

Viscosity Tests—As has been explained already, the value of lubricants depends on the fact that the internal friction between their particles is less than between the surfaces to be lubricated. Since the rate at which a liquid will flow through any aperture increases as this internal friction decreases, we can compare this internal friction (which is really about what we mean by "viscosity") in a number of oils by determining the time it takes equal volumes of each oil to flow through the same opening.

In almost all cases this is how we measure "viscosity," and provided we determine the viscosity at a temperature as nearly as practicable that of actual use and also determine how the viscosity changes with changing temperature, the viscosity test is the most valuable single test that can be applied to an oil. It is important to remember, in this connection, that oils that exhibit at "ordinary" temperature practically the same viscosity, may vary widely at the temperature of actual use, a fact frequently disregarded with disastrous results.

Viscosity is the most inconstant of the "constants," and a desirable range to cover practically all uses is from about 170 to 700 (at 100 F.) in the case of asphalt-base oils, or from 140 to 500 in the case of paraffin bases.

Viscosities ranging from the lower limit in both cases up to, say, 201 or 300 would be satisfactory for dynamos, turbines and light or medium heavy motor-engines, while the higher viscosities up to 700 or even 750 would be suitable for main engines with forced feed, very heavy turbines and motors, for large Diesel engines, air compressors, etc.

In light motor oils a viscosity of about 180 (100 F.) will give a maximum horsepower output with a minimum fuel consumption, according to C. W. Stratford, lubrication engineer, but were it not for the disposition of oils of a notably higher viscosity (that is, about 300) to form carbon deposits, these would come nearer meeting most motor needs.

Of course it must be remembered that only where the bearings are "flooded" with oil or in the case of very light machinery running at a high speed is the friction due to the lubricant alone; in the majority of cases perhaps the friction is due in part at least to actual contact between the moving surfaces, and where this metal contact is persistent, leading to the abrasion of metal and its incorporation into the metal, forming a kind of metal soap, there is an enormous increase in friction.

Durability Test—The most valuable lubricant is, of course, the one that retains good lubricating qualities for the longest period. Assuming that each of a number of oils is equally free from objectionable impurities and that they are used under identical conditions, the one of simplest composition (that is, the one that comes nearest to being a pure chemical compound, or to express it in other words, contains the least number of different hydrocarbons) will be the one that will "stand up" better in actual service.

A valuable test for indicating this proximate composition of lubricating oils has been devised and successfully used by James G. O'Neil, chemist at the United States Navy Engineering Experiment Station at Annapolis, and published in the *Journal of the American Society of Naval Engineers*. In brief, this test consists of a fractional distillation of the oil by means of superheated steam and the determination in this way of the number of fractions of approximately the same volume into which the oil may thus be "split up."

The smaller the number of such fractional volumes, the greater the probability of the oil retaining its original properties in use. Mr. O'Neil showed that "the life of a lubricating oil can be estimated, and that those oils containing the larger percentage of component parts having viscosities between 140 and 500 Saybolt (at 100 deg. C.) give longer service than will those oils that are lower in those fractions."

Where there is a much wider range of viscosity, it generally means that this (as well as other "constants") is the result of mixing light and heavy "ends," as they are called, and in use it may well happen that the light ends distill off, leaving a very viscous residue of a high internal friction. Of course, it must not be understood that it is always desirable or possible to use lubricating oils whose viscosity lies between the limits given, for in many cases qualities other than durability may have to be given prime consideration.

Evaporation Test—Provided this test is made at a temperature that bears a logical relation to the temperature the oil probably reached in actual use, it may be made of very considerable value.

Battle has called attention to its value as a measure of the actual loss of oil in use and as a means of determining the real "ultimate economy" of lubricating oils. It is obvious that where an oil is a "blend" of light and heavy ends, the loss of the former in actual use may entail not only an indirect loss from increased friction of the heavy residue, but a direct financial loss through the purchase of material with little lubricating value under the actual conditions of service.

"Gravity" Test—It is now generally recognized that this test indicates very little other than the nature of the crude from which the refined oil is made, paraffin-base oils giving a lower specific gravity but higher Baumé gravity than oils made from asphalt-base crudes.

Formerly, unfortunately, a proviso as to the "gravity" of an oil was almost the sole item in specifications, and equally unfortunately, a belief in the value of this constant still persists in some quarters.

Flash and Fire Point Tests—Provided these tests are made with due regard to the temperature of actual service, they should form a part of the routine tests of most oils, especially those used in cotton or woolen mills or other plants manufacturing highly inflammable material. The practice, frequently indulged in, however, of determining that a given oil flashes at, say, 450 deg. F., when in service it may be subjected to a temperature of many hundreds of degrees higher (as, for instance, in the case of oils for internal combustion engines), is obviously a loss of both time and material.

Cold Test—Cold test, cold point, pour point, cloud test, chill point, etc., are different names that describe more or less the same thing; that is, the evidence of the result of exposing lubricating oils to low temperatures. Like flash and fire points the results depend very largely on the way in which the test is made. In the case of oils for the lubrication of railway rolling stock and for ice machines, the cold test is of prime importance. For the latter use the oil should flow at a temperature at least as low as —15 deg. F., while railway companies rarely require a minimum cold point of less than 0 deg., or possibly, in extreme cases of —5 deg. F.

Asphalt-base oils give a lower cold test than those from paraffin bases.

Some of the extremes of temperature to which lubricating oils are exposed in internal-combustion engines are shown by the following table:

	Deg. F.*
Heat of explosion	2,000 to 3,000
Piston-head temperatures	300 to 1,000
Piston walls	200 to 400
Cylinder walls	180 to 350
Crank bearing oil	140 to 250
Sump oil	90 to 210

*Later investigations have shown that the maximum temperature is probably not over 2,700 F. (See *Journal Soc. Naval Engineers*, February, 1915, "Motor Cylinder Lubrication," G. S. Bryan, U. S. N.)

On the other hand, specifications for ice-machine oils require a cold test of as low as minus 30 degrees.

Adequate Economical Lubrication

The number of oils that are needed for adequate economical lubrication, of course, will depend very much on the character of the plant for whose lubricating needs we are to provide. Even in a moderate-sized plant, though, there will be a sufficient variety of machines operating under conditions differing enough to make it an extremely uneconomical practice to throw upon one oil, or even upon a limited number, the burden of meeting a number of operating conditions.

The eminent English authorities, Archbutt and Deeley, write upon this subject as follows:

> Although it is clear that for each kind of bearing, speed and load, only a few varieties (of oils) will be found to give equally good results, the great disadvantage of having a great number of oils in use at the same time is so great that practical men prefer as a rule to use only a few. This limitation may, however, be carried to an extreme, and great waste of power results.

The following examples show the number of oils used by some very large consumers:

1. A big city-railway system uses eight, of which three are for their shops and rolling stock.

2. The United States Navy at one time had specifications for the following varieties of oils: (a) Oils for reciprocating engines without forced feed; (b) oils for forced-feed lubrication of reciprocating engines; (c) oils for turbines; (d) cylinder oils for ordinary use (saturated steam); (e) cylinder oils for superheated steam; (f) motor-cylinder oils (light, medium and heavy); (g) dynamo-engine oils; (h) ice-machine oils; (i) aëroplane-motor cylinder oils.

It is desired, however, to reduce this list to: (a) One ice machine; (b) one steam-cylinder oil for saturated and one for superheated steam, and one marine-engine oil; (c) three oils for general lubrication covering requirements other than the foregoing, these to be light, medium and heavy respectively, to use in turbines, all forms of forced-feed or splash lubrication, dynamo engines and in internal-combustion engines (including Diesel type).

Classification of Oils According to the Use Made of Them

Probably the most generally adopted classification of oils based on the character of the machine in which they would be used is: Gas and steam engine-cylinder oils, engine oils, dynamo oils, transformer oils, turbine oils, ice-machine oils. The gas-engine cylinder oils are preferably subdivided into light, medium and heavy (referring to viscosity and not to specific gravity). In like manner steam-cylinder oils are usually classed as: for saturated steam and for superheated steam.

After all, it is not so much the machine but the service conditions that determine the kind of oil to use.

Of course the mere fact that an oil possesses the proper physical constants is no proof that it will give satisfactory service; that will depend on proper refinement, insuring practical freedom from injurious impurities, and will also depend to a tremendous extent on proper care in its use; for all lubricating troubles do not by any means originate in poor lubricants, but probably much oftener in the careless use of good lubricants on poorly designed and dirty bearings or in the use of inadequate amounts of lubricants.

A COMPARISON OF THE "CONSTANTS" OF ASPHALT-BASE AND PARAFFIN-BASE OILS, RESPECTIVELY: SUITABLE FOR VARIOUS USES

For Light Force-Feed Oils (Dynamos, Turbines)

A = Asphalt; P = Paraffin;

	Sp. Grav. (60° F.)	Flash Point (Open Cup)	Fire Pt., Deg. F.	Cold Pt., Deg. F.	Viscosity (Saybolt) at 100° F.	130° F.	210° F.
A	0.926–0.937	364–384	364–384	—5–10	134–206	75– 96	40– 51
P	0.864–0.882	364–410	424–444	5–30	139–170	84–100	43– 46
			For Medium Forced-Feed Oils				
A	0.920–0.933	296–334	328–392	—5–0	220–275	107–121	45– 47
P	0.875–0.910	386–446	436–506	5–30	199–295	96–144	43– 53
			For Heavy Forced-Feed Oils				
A	0.924–0.937	312–378	332–428	—0–7	310–750	137–254	49–58
P	0.875–0.908	388–490	426–546	13–54	335–1630	161–172	56–130
			For Extra-Heavy Forced-Feed Oils				
A	0.940	400	420	—5–0	750	.....	.....
			*For Cylinder Oils (Saturated Steam)**				
					130°	210°	300°
P	0.894–0.921	455–552	525–594	40–55	760–1250	130–230	.....
			For Cylinder Oils (Superheated Steam)				
P	0.897–0.915	484–597	510–640	30–50	843–1887	155–312	60–91
			For Marine Engine Oils				
					100° F.	130° F.	210° F.
A	0.940–0.0696	350–375	400–425	5–10	679–933	293–354	72–81
P	0.883–0.920	395–433	441–494	15–40	335–585	163–274	56–81
			For Ice Machine Oils				
A	0.900–0.929	278–313	318–344	—15–26	107–128	67–75	39–42
P	0.872–0.895	360–373	388–408	—5–25	105–110	65–66	39–39

* No asphalt-base oils are used for cylinder oils.

In oil engines with water-cooled exhaust valves the cavity in the valve should be cleaned with muriatic acid at frequent intervals. Due to the high temperatures of the valve body there is a tendency toward deposits at points where the water circulation is not rapid.

The Solubility of Air in Water and Its Relation to the Performance of Feed-Water Heaters

By J. R. McDermet*

The presence of air in solution within a boiler is objectionable mainly on account of its corrosive effect on boiler plates and tubes. Feed-water heaters of the open type are expected to remove most of this air. The author applies the laws governing the solubility of air in water to feed-water heaters and shows that there is no certainty that the air will be driven out of solution unless the heater is operated at temperatures above 155 deg. F.

ATMOSPHERIC air is a gaseous mixture composed substantially of one-fifth oxygen and four-fifths nitrogen with variable though small proportions of such gases as argon, hydrogen, ammonia and carbon dioxide. The barometric pressure which dry air exerts is composed of two partial pressures—that of oxygen equal to one-fifth of the total and that of nitrogen equal to the remaining four-fifths. The solubility of a pure gas which does not unite chemically with the solvent is directly proportional to its pressure at constant temperature (Henry's Law). The solubility of the components of a gaseous mixture follows exactly the same law except that the partial pressures of the constituents instead of the total pressure of the mixture need to be considered (Dalton's extension of Henry's Law). Air boiled off from water, however, contains respectively 35 and 65 parts of oxygen and nitrogen. Gases have different solubilities so that the mixture in solution may be very different from the mixture from which it was

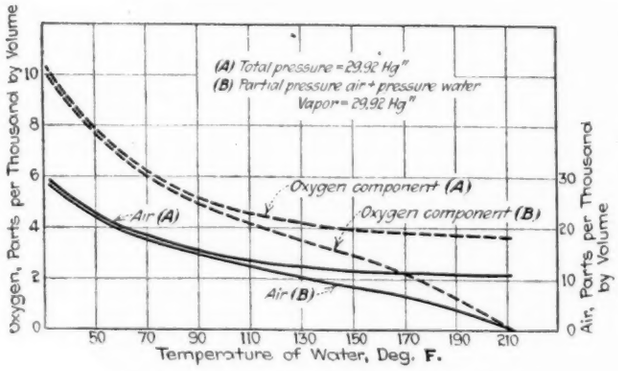

(A) Total pressure = 29.92 Hg"
(B) Partial pressure air + pressure water Vapor = 29.92 Hg"
Oxygen component (A)
Oxygen component (B)
Air (A)
Air (B)
Oxygen, Parts per Thousand by Volume
Air, Parts per Thousand by Volume
Temperature of Water, Deg. F.

FIG. 1. SOLUBILITY OF AIR BY VOLUME

formed. The application of the pressure law is invariable, however, and if the pressure be doubled the amounts dissolved are doubled. For gaseous mixtures the relative proportions of the gases dissolved are constant, although the quantities themselves are variable with pressure.

Solubility in general is inversely proportional to temperature, but the law is neither simple nor always applicable. Solubility curves are accordingly experimental, and for a specified gas and solvent involve the variables temperature and pressure, of which the latter is difficult to control. For gaseous mixtures the experiments must be so conducted that the relative proportions of the saturating components be constant irrespective of the pressure or dilution, and the pressures and temperature must be known. Having such a temperature solubility curve for a definite pressure, the values may be calculated into any other pressure condition.

Dissolved air and the oxygen content of the dissolved air are ordinarily the only gases in water significant to the engineer; the former because it is a limiting factor

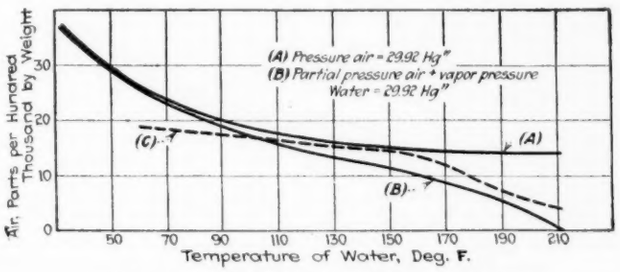

(A) Pressure air = 29.92 Hg"
(B) Partial pressure air + vapor pressure Water = 29.92 Hg"
(C)
(A)
(B)
Air, Parts per Hundred Thousand by Weight
Temperature of Water, Deg. F.

FIG. 2. SOLUBILITY OF AIR BY WEIGHTS

in all processes involving the heating or cooling of water in a closed vessel—for in apparatus of the direct-contact type, such as open heaters and jet condensers, it creates a partial pressure and reduces the temperature; while in apparatus such as boilers, surface condensers and closed heaters, where the heat transfer is through a separating partition, it covers this partition with a non-conducting air film which interferes with the heat transfer—and the latter on account of the corrosive action of heated water containing it. Capacities of air-removal machinery are ordinarily given in pounds per hour at a specified pressure or vacuum to avoid calculations for standard gas volume. Dissolved oxygen content in relation to corrosion is almost invariably expressed in the chemist's units of cubic centimeters per liter, the gas volume being calculated at 32 deg. F. and standard atmospheric pressure, 29.92 in. of mercury. These conventions require the expression of dissolved gas quantities in two systems of temperature co-ordinates, parts per hundred thousand by weight, and parts per thousand by volume, which is equivalent to cubic centimeters per liter.

The solubility curves that accompany this article are based on Winkler's figures, which in the writer's opinion are the most accurate and carefully taken. These data are derived with an absolute partial air pressure of 29.92 in. of mercury. From the pressure law it is obviously immaterial what the total pressure may be, provided no gases are present which unite chemically with the water, but in the case of the Winkler values at high temperatures the total pressure must be augmented at least by the vapor pressure of the water. The Winkler figures are substantially correct below 70 deg. for ordinary usage and are desirable because of their direct experimental origin.

A second series of curves is supplied in which the Winkler values are calculated into a total pressure equal

*Research engineer, Elliott Company.

to atmospheric. The partial air pressure to saturate the water is then 29.92 minus the vapor pressure of the water. These curves, although derived from calculation, are rigorously applicable at all temperatures below 150 deg. F. At high temperatures the pressure conditions are unattainable in closed vessels without careful experimental control. Above 150 deg. F. the direct and the derived curves are, respectively, the upper and lower limits between which the solubility of the gases will always lie. At these temperatures accurate partial-pressure determinations are extremely difficult to make and the data are in their most useful form.

In Fig. 2 a third curve (*c*) is added to illustrate some points of practical significance. This curve was derived in the laboratory by heating samples of water at a uniform rate to the temperatures at which the dissolved air content was to be determined. The true solubility curves are for water in equilibrium with the air, and the equilibrium condition requires a very considerable time, the interval being appreciably longer on heating than on cooling, and is not ordinarily attained in engineering practice. At a temperature of 155 deg. F. this curve shows a point of inflection and bends downward very rapidly, owing to the formation and escape of vapor-air bubbles which are effective in removing air. This point is significant in the performance of open feedwater heaters. At lower temperatures such heaters may cause air to be taken up by the water passing through them, if it is not already saturated, up to the limit of solubility; at higher temperatures they may drive the air out of solution under favorable conditions. Under these conditions, however, it is necessary to withdraw a mixture of steam and air from the heater, in order to reduce the air component of pressure within the heater, which would tend to maintain the air in solution. The heat value of the steam is therefore wasted.

The open heater pressure, the heater being a closed vessel, is composed of two partial pressures, that of a steam component the temperature of which is the maximum theoretical temperature that the heated water can attain, and an air component which has the effect of reducing the air removal that the heater is able to accomplish, and simultaneously of reducing the theoretical temperature of the water delivered. Because of this partial air pressure a heater is intrinsically incapable of giving air-free water; the values of dissolved air will always lie between the two limiting curves, one for a total pressure of 29.92 in. of mercury and one for a partial air pressure of 29.92 in. of mercury.

The heater designer is confronted with one of several dilemmas. At low temperatures the solubility of air in water prevents effective air removal. At high temperatures efficient air removal and heating can be secured only by wasteful and excessive venting. If wasteful venting is avoided, the presence of air reduces the temperature of the water and increases the amount of dissolved air. The designer approximates as best he can the mean of these conditions.

Fishing a Pump Cylinder from a Well

By A. J. Dixon

An engineer in charge of a steam-driven deep-well pump had occasion recently to fish the pump cylinder from the bottom of the well, and he had some difficulty in doing it. The diameter of the pump cylinder is 5 in. and the stroke of the plunger 36 in. The cylinder was attached to a 5-in. drop pipe which descended to a depth of 130 ft. below the ground level. The well is lined to the bottom with a 12-in. casing.

While at work one day the pump suddenly ceased to deliver water. The behavior of the steam actuating mechanism indicated that something had gone wrong with the pumping mechanism below ground. When the 130-ft. drop pipe was pulled to the surface it was found that the cylinder had separated from it and had dropped to the bottom of the well, about 275 ft. below the ground level. The problem then was to grapple the cylinder and fish it out. For this purpose the engineer made a grappling device of the form shown in Fig. 1. This was lowered with a rope attached to the eyebolt. The idea was to slip this tool into the cylinder. Then when the rope would be drawn taut the teeth of the dog would bite into the wall of the cylinder.

But the grappler did not work according to expectations. The difficulty was to get it to enter the cylinder. The top end of the cylinder had evidently tilted over

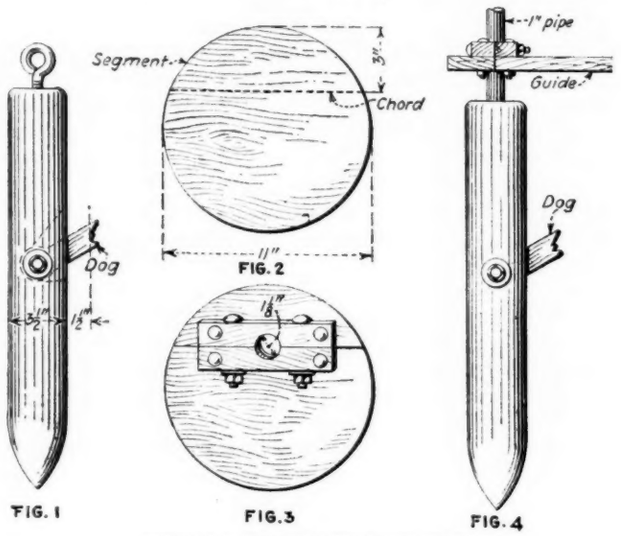


FIG. 1 FIG. 2 FIG. 3 FIG. 4

DETAILS OF GRAPPLING TOOLS

against the casing, thus causing the opening in it to incline at an angle to the horizontal. After a vain attempt to locate the opening in the cylinder the engineer concluded to try another idea.

The grappler was drawn to the surface, the eyebolt was removed and the hole was drilled and tapped for a 1-in. pipe. A circular board, about 11 in. in diameter, was then sawed out of 2-in. planking. A 3-in. segment was laid off on this board as shown in Fig. 2, and a block of wood 2 in. thick was set centrally over the chord of this segment and was fastened on with carriage bolts in bored holes. A 1⅛-in. hole was bored through the block and board as indicated in Fig. 3. Holes for the clamping bolts were likewise bored through the block, and the segment was sawed off. A piece of 1-in. pipe was then screwed into the grappler, and the circular board was clamped on as indicated in Fig. 4.

With this addition the grappler was again lowered into the well. But instead of the rope, lengths of pipe, successively screwed together, were used. Then when the grappler reached the bottom the circular board served as a guide while the men above were stabbing around with the grappler and attached pipe close to the periphery of the casing. By this means the opening in the cylinder was located. The grappler took a firm hold and the cylinder was raised to the surface.

Progress Report of Superpower Survey

Investigations Shaping Into Definite Recommendations Concerning the Physical, Legal and Financial Aspects of the System

A PRELIMINARY report covering the investigations of the Superpower Survey is set forth in a communication prepared by W. S. Murray and transmitted under date of February 24 to the President by the Secretary of the Interior, John Barton Payne. The progress thus far warrants the belief that the report will be completed by June 30, 1921.

The report resolves into three divisions, physical, legal and financial. With reference to the first of these the investigation has been concerned with the power necessary to railroads, industries, utilities, and lastly, a system of centralized electric generation and transmission to supply their power requirements up to and including 1930.

There are twenty Class 1 railways in the superpower zone involving 14,500 miles of first track, 8,500 miles of second track, or a total trackage of 36,000 miles, including yards and sidings. There is a total of 10,000 steam locomotives, of which 44 per cent are freight, 29 per cent passenger and 27 per cent switching. The total annual railroad coal consumption for 1919 was 19 million tons.

Would Electrify One-Third of Mileage

Apparently one-third of this mileage can be economically electrified, including the greater part of double-track mileage. Owing to lack of traffic density upon the branch lines these cannot be profitably electrified. This 33 per cent of mileage will carry more than 50 per cent of the traffic, and by preferential arrangement of routes probably 60 per cent of the total traffic could be put over this mileage.

Through the electrification of this mileage a fuel saving of 6,000,000 tons, or $40,000,000, per annum would be effected. Added to this saving will be $50,000,000 annually as a difference in favor of electric versus steam-engine repairs and maintenance.

The total unit cost of electrification will be approximately $40,000 per mile of main-line track, which, with 12,500 miles to be electrified, would cost $500,000,000. In addition, yard and siding trackage would call for $300,000,000, or a total of $800,000,000. This sum will cover the necessary construction and equipment for the railways, beginning with the electric substations and with the driving wheels of their electric motive power.

The electrification herein outlined will displace approximately 7,000 steam locomotives, which, at salvage value of $22,500 each, will credit the electrification estimate with approximately $150,000,000, leaving a net investment of $650,000,000, which, taken in connection with the aforementioned savings of $90,000,000 per annum, would return approximately 14 per cent on the investment.

Industries in the Superpower Zone

There are approximately 50,000 industrial plants in the zone which either purchase or generate power.

The Bureau of the Census is at present compiling the statistics of the 1919 census of manufacturers. As soon as the tabulations are completed the Survey will analyze and ascertain what possible fuel savings could have been made by the Superpower System in 1919. From the data at hand a saving of between six and eight millions of tons of coal is indicated.

In the anthracite mines of Pennsylvania, by means of electrification and the supply of superpower, a conservative estimate based on actual tests shows a saving of 6,500,000 gross tons of anthracite.

Savings in Public Utility Plants

The average rate of coal consumption for present central station output is 2¾ lb. per kw.-hr. It is estimated that power can be produced in the Superpower System at an average rate of 1¾ lb. per kw.-hr. The present central station output of coal-generated power within the zone is 8,000,000,000 kw.-hr. Therefore one pound saved per kilowatt-hour will conserve 4,000,000 tons of coal annually.

The location of the large superpower stations and their attendant transmission lines is related to the establishment of load centers throughout the superpower zone to which power will be transmitted from them at minimum distance.

To date it is indicated that some twenty load centers will be established, and sufficient data will soon be at hand to establish these load centers, after which the location of new superpower stations and their interlinking transmission systems can be promptly determined within the zone.

The development of power outside of, but for transmission to, the zone is being carefully considered, having relation to the St. Lawrence River, other hydro-electric powers and the bituminous coal mines. It has been agreed among the experts that 250,000 volts will be an acceptable voltage for the transmission of power from distances greater than 200 miles, and at about half that value for the zone itself.

A conference with the coal authorities indicates that a fair figure to take for the average price of coal during the period 1919 was $2.90 per ton at the mine, and that during the period from that date to 1930, $3.50 per ton.

Steam Power Will Predominate

With regard to water power for the zone, a summation of the possible outputs from the Potomac, Susquehanna, Delaware, St. Lawrence (American rights), Raquette and the Adirondack powers indicates that for an average year there will be available 12,000,000,000 kw.-hr., and for a minimum year 8,360,000,000 kw.-hr.; the plant capacity being 2,300,000 kw. to furnish this amount of energy. It is of interest at this point to state that in 1930 the total power requirement in the superpower zone indicated by projected growth curves will be 48,000,000,000 kw.-hr., of which amount the Superpower System could supply 36,000,000,000 kw.-hr. This, therefore, indicates that the water power supply can be but from 20 to 25 per cent of the total.

The report will contain a chronology indicating time and location of superpower stations to be constructed in the order of their requirement, giving savings to be effected as their serial installation is made.

Concerning legislative and financial status, the following paragraphs represent the general expression of opinion at the Washington meeting of the Advisory Board, Feb. 18.

Legislation should take the form of an act permitting the formation of a corporation authorized to take by eminent domain lands or interests therein necessary or appropriate to the construction, maintenance and operation of lines for the transmission of electric energy. Such legislation may be by a separate act or by an amendment to the Federal Power Commission law.

As a condition precedent to the formation of such a corporation the proposed incorporators should be required to apply to the Federal Power Commission for a certificate that the project is desirable and is justified in the public interest. This application should be followed by a hearing after due notice to the governors of the states through which condemnation rights are asked. If the certificate is granted the incorporators should be permitted to form a corporation with the usual powers, and in addition thereto (subject to the approval of the utility commission of the state where the power is to be exercised), the right to construct, maintain and operate power plants and transmission lines, the right to purchase electrical energy from and sell it to electrical power-producing and distributing companies.

All these rights should be subject to the exercise by each state of its full police and taxing power.

It will be observed that herein no new right is created as against any state, except that of taking by eminent domain the location of a transmission line for the transportation of electrical energy in interstate or foreign commerce. Each state retains unimpaired power to fix rates, to determine the character of structures, and to lay and collect taxes to the same extent as such authority is exercised over power producing and distributing corporations of its own creation.

Financial Considerations

The plan of financing that has been suggested is based on the supposition that the Superpower System is in its very nature an extension of present power-supply systems, whereby, combining several large plants with present relatively small plants, economy in generation and conservation of natural resources can be secured over that at present attained. Therefore, the vested rights of existing public utility power generating and distributing companies should be protected.

Dependence must be placed on the incentive of private initiative to lower costs and on some form of public regulation of prices to the consumer. The power generated and distributed by the Superpower System will finally be distributed to the public by means of existing companies, and the economies to the public utility companies which will result must ultimately be reflected in prices to the consumer through the action of present state regulating bodies.

The financial plan in bare outline provides for a superpower company with non-par stock as its only class of security; the public utilities within the Boston-Washington zone to be entitled to subscribe for this stock pro rata, based upon capacity demand and load factor; stock not taken by these customers of the Superpower System to be offered to public subscription.

A contract between the superpower company and a local public-service company would be a selling contract or a buying contract, while in many cases both buying and selling of current would be involved. These contracts on which the state regulatory bodies would pass would be adjusted from time to time to meet the progress of the art and changing conditions, whether favorable or unfavorable to costs of operation.

Benefits to be Safeguarded

Returns upon the stock of the superpower company should be limited by specific provision to a fair division of the benefits derived from its operation between the investing public and the consumers that will make it possible for the superpower company to come into existence and at the same time be able to serve the public adequately. New capital is the keystone of the project, but the public demand is its foundation. This division of benefits would be attained by a rule under which the customer companies shall participate equally with the stockholders in any distribution, at stated intervals, of net earnings in excess of a specified rate of return, which itself should be more liberal than is commonly contained in the idea of public regulation. Thus efficiency in management would be rewarded and the public interest directly served. To secure the participation of the ultimate consumer in this division of benefits, provision should be made that the superpower stock held by any public-service company be regarded as representing an extension to its existing station capacity rather than be considered as an outside investment security.

Absolute publicity of the superpower company's operations will be an essential condition. Freedom of action should, however, be also sought for this company in order to promote the free flow of capital to this enterprise whose requirements will be large and continually increasing.

Before the Days of Pressure Gages

Among arrangements for facilitating the control of the pressure in the boilers of high-pressure engines, may be named principally the manometer, an instrument well known. After once proved, it is eminently trustworthy and becomes indispensable to the engine attendant in regulating his firing according to the varying pressure of the steam in the boiler. In high-pressure engines the ordinary mercury gage used for low-pressure cannot be employed, as the mercury column would be required inconveniently long. This is to be regretted; for this apparatus is undoubtedly more simple and secure, and less liable to derangement than the manometer, which has the evil, that in case of a vacuum being accidentally formed in the boiler, the air above the mercury is so apt to escape. The only way to prevent this danger is either to shut off the communication between the boiler and the manometer by a cock while the engine is standing, or to provide the boiler with a vacuum valve.

Gages for steam pressure on the principle of the spring steelyard have often been recommended. Upon an instrument of this description is fixed a small piston, working steamtight in a cylinder exposed to the pressure of the steam. The more the pressure increases the higher rises the piston, and the resistance of the spring, increasing in like ratio, is indicated by an index pointer. But it is impossible to expect exactitude in an insrument of this description, where the variable friction of the piston must so much influence the correctness of the indications.—*The High-Pressure Steam Engine. By Dr. Ernst Alban (1847).*

EDITORIALS

An Engineer in the Cabinet

IT WAS not so very long ago, as the world wags, that to the average citizen the term "engineer" pictured an unkempt individual in greasy overalls, wielding a monkey wrench. Employers looked askance at technical graduates as "too theoretical," and "Bert" Hoover, Stanford '95, was pushing a mine car at $2.50 a day.

But times have changed and viewpoints as well. Charter members of the A. S. M. E., still in the prime of life, have seen the engineering profession grow to become a recognized power in civic affairs, and today the American Engineering Council, as the executive organ of the Federated American Engineering Societies, representing a membership of over one hundred thousand engineers, is, among other activities, conducting a nation-wide "assay of waste," which already shows promise of far-reaching economic results, and taking a long step toward the fulfillment of its function as "a comprehensive organization dedicated to the service of the community, state and nation."[1]

In "The President's Cabinet" (1911), Dr. Hinsdale wrote, "The latest tendency in the selection of Cabinet officers is to increase the proportion of men who are primarily distinguished for skill in administering large professional or business interests."

Without going into the merits of subsequent incumbents of the office, this statement seems almost prophetic with reference to the selection of Mr. Hoover for the portfolio of Secretary of Commerce, and the President is to be congratulated on the choice and acceptance of a man for this particular seat at the "long table," whose abilities as an organizer and executive are recognized and admired the world over, regardless of creed or party.

The headlines in the morning papers of February 25 and 27 respectively, reading "Hoover Accepts Cabinet Position" and "Hoover Looks Over His Department" are indicative of the methods that Roosevelt doubtless had in mind as appropriate for the conduct of this particular governmental branch when he succeeded, in 1903, in securing the necessary legislation for its creation.

Availability and Reliability

A FEW months ago *Power* discussed editorially the question of availability and reliability of power-plant equipment, and the need of records of these characteristics of plant equipment were pointed out. Reports have come into this office since that time of various troubles with equipment in many large power stations, together with stories of excellent performance on the part of other equipment.

In this connection it is interesting to note the performance of the twenty-five thousand-kilowatt steam turbine furnished to the Fisk Street Station of the Commonwealth Edison Company of Chicago, by C. A. Parsons & Sons, England, in 1914. This turbine in its six years' service is said to have established a remarkable record for itself, not only for its availability for and reliability in service, but also for its sustained high economy. It will be recalled that the guaranteed steam consumption of twenty thousand kilowatts was 11.25 pounds per kilowatt-hour with two hundred pounds per square inch gage pressure, two hundred degrees Fahrenheit superheat and one inch absolute exhaust pressure. It is significant that the speed of this machine is only seven hundred and fifty revolutions per minute. Can it be that some of our American designers, in striving after high rotative speeds and low first costs, have sacrificed some operating advantages inherent in the slow speed turbines?

Constructive Progress Shown in Superpower Report

IN THIS issue there appears in substance the letter of John Barton Payne, Secretary of the Interior, to President Wilson, transmitting the Progress Report of W. S. Murray, Chairman of the Superpower Survey, which was presented in Washington at the third meeting of the Survey's Advisory Board, February 18.

It is clear from the summaries of facts presented that remarkable progress has been made in carrying out the purpose of the Survey. When it is remembered that one year only was allowed for the presentation of the report it will be seen that only by the active co-operation of the public utilities, the railroads and the industries would it have been possible to co-ordinate such a vast amount of material in so short a time. Opportunities for conservation and steps toward the collection of data to show how coal can be saved have been undertaken by other bodies, but no body before this has attempted to visualize the whole problem within this very active industrial zone, to co-ordinate present information, make new investigations to fill the gaps in present knowledge, and present the whole from the viewpoint of fundamental economies in the utilization of power and the conservation of coal in this region.

The zone covered by the Survey is a specialized one, with specialized problems. While the Survey has included the consideration of all forms of power within this region, it has been found that coal will remain the primary form of power in this particular zone. It is, consequently, highly important that the broad conservation movement outlined in the preliminary report be kept clearly before both the public and the utilities, the railroads, and industrial plants. Industrial expansion and increased railroad capacity depend upon adequate, reliable and economic power. The final report of the Survey should suggest the principles by which these results can be attained.

That the Engineering Staff and the Advisory Board of the Superpower Survey are conscious that an engineering report alone will not meet the situation, unless a plan of procedure is suggested for carrying out the economies mentioned, is clearly indicated in the report. The problems of financial, legislative and legal machin-

[1] Preamble to the Constitution of the Federation.

ery necessary to carry out the Superpower Survey plan are many, but the staff is approaching them with a very real sense of its responsibilities and the opportunity to serve both the public and industrial interests involved from the broad viewpoint of saving forty to fifty million tons of coal annually. The project is too great and the investment too large to be undertaken by any one utility or group of utilities concerned. Hence the proposal of a superpower corporation that will function on broad lines and to which the utilities will subscribe and have a directing interest. This corporation must share the confidence of the consuming public and the industries served, and to this end it will be subject to existing state regulatory bodies so that the consumer may share with the utility the benefits of superpower. In this connection it is most important that there be no conflict of interstate with intrastate authority.

Electric Heating of Steam Boilers in France

CERTAIN industries, such as textile and paper mills and some chemical works, which use steam in their manufacturing processes for purposes other than the production of power, have been forced by the excessive cost of coal to give more and more consideration to economy in steam production. Furthermore, the rising cost of labor together with the relatively small quantities of steam actually required in these processes make it increasingly desirable to eliminate the labor item from the cost of the steam. These several causes have drawn the attention of the engineering world to the simplicity of control and automatic operation of electrically heated boilers, though they have met with little more than theoretical interest in most countries.

Considering only the actual cost of energy, electric power is under a heavy handicap as compared to coal for the heating of boilers, and it must sell for about one-half cent per kilowatt-hour to compete even with low-grade coal at the very high price of $35 a ton, burned under inefficient boilers. Yet the economy of a fireman's wages, and many "imponderables," such as simplicity and great flexibility of operation, cleanliness and space economy, work in favor of electric heating.

The electric boiler is still in the realm of research in this country, but is rapidly gaining ground in two European countries—Switzerland, where water power is available in excess of the demand during the greater portion of the year, and Italy, where coal can be bought only at prohibitive prices. France has been much slower to adopt the new system. Though it has been under study by French engineers for many years, the pioneer installation, which is described in a paper by G. A. Maillet, abstracted in this issue, was not put into operation until September, 1919. The experiment was made in a paper mill in the Alps, and the results were so successful that the installation was at once expanded, and two new boilers were added within a year, the largest in the world, each consuming nearly 4,000 kw. at 6,500 volts. At the same time a determined campaign has been started to develop this new field for electric power in the mountainous regions of eastern France, which are actively engaged in textile and paper industries.

The results of this campaign are still in the balance and will probably be disappointing for several years; for electric heating of boilers cannot be separated from the general problem of electric heating, and meets with the same obstacles. Under normal conditions its field is narrowed down to uses for which heat is required in such small quantities that the greater cost of energy is outweighed by the greater convenience, simplicity and cleanliness of the system. For all other uses it has small chance unless electrical energy is available at much lower rates than motive power can command; and power companies will never sell power at the lower rate unless they have no other market and the energy would otherwise be wasted. Such is the condition on hydro-electric systems at times of high water or at night, and it is probable that in countries where water power is abundant, a sliding rate for electric heating will prove profitable for both the power company and the consumer.

Such is undoubtedly the condition in Switzerland, which explains the success of electric heating for boilers in that country. This is not the case, however, in France; the rapid development of industry during the war and the destruction of the majority of the coal mines in that country have thrown a heavy demand on hydro-electric power. Moreover, there has been very little development of new water power to meet this demand, for lack of labor and materials. For these reasons, hydro-electric power is still at a premium, and so it will probably remain for some time; and it therefore commands rates that are prohibitive for heating purposes.

Coal Storage

COAL production is on a seasonable basis. This is because its consumption is on the same basis. As a great deal of the coal burned in this country is used for heating there is no hope of creating a uniform demand, but there is no particular reason why production should not be uniform, and efforts in the future must be made to smooth out this difficult and embarrassing phase of the coal situation.

To do this the question of financing must be settled. Who is going to pay for the enormous stocks stored for future demands? There has been an impression in the past that coal in storage deteriorated. Chemical analyses indicate that the loss is not so serious as generally supposed and that coal in storage for considerable periods shows little reduction in heat value.

It may be that the impression of deterioration has been brought about by the practice of storing coal on the ground outdoors and by the careless shoveling of the coal back into cars when it is to be used. If any considerable amount of dirt goes back with the coal it will, of course, increase the ash content and cause trouble. Coal should be put down on an area from which it can be removed with the minimum addition of foreign matter.

Study of the methods of coal handling and improvements that are possible bring the deterioration of coal in storage to a minimum and place the storage of coal on a better financial basis than ever before. Once it is realized that coal can be stored with a reasonable degree of certainty and with little or no depreciation, means will be found to finance the accumulation of coal in the summer time and at other times when transportation facilities are available, so that these stocks of coal will be at hand to meet the increased demand for fuel in the colder months. For the advantages obtained the mine, the railway and the consumer could each afford to share a proportion of the storage expense.

CORRESPONDENCE

Running a Vacuum Heating System Condensing

On page 237 of the Feb. 8 issue of *Power*, Mr. Cultra had an article on running a vacuum-heating system condensing, but my experience has taught me that no new conditions are necessary other than a regular standard vacuum-heating system to run an engine condensing.

How does Mr. Cultra maintain 15 in. of vacuum on the engine if the closed heater drip is open? And if it is closed, what prevents it from filling with condensate and, when the engine is shut down drawing it into the cylinder and causing a wreck? He does not mention opening a vacuum breaker before shutting the throttle.

Others have been up against this mongrel condensing system before. I once operated an up-to-date vacuum heating system. My predecessor tried to run the engine condensing and he did, but one day he saw the water glass on the boilers accumulating oil, which indicated that there was oil in the boilers. He opened them up and found that they were loaded with cylinder oil, which of course was a result of running condensing, the drip from the closed feed-water heater going to a sump which contained mostly drip oil and water from the heater. When he got a vacuum, it drew this oil up through the feed-water heater to the vacuum pump and then into the receiver, and the feed pump finished by putting it into the boilers.

We put a check valve on the heater drip so that this water and oil could not be drawn out of the sump, which did stop it, but this check valve was sucked so hard to its seat that the heater would not drain, but accumulated water. Then a ¾-in. open-end nipple was put on between the check valve and the heater. This seemed to be the only way out of it, but of course it reduced the vacuum, although it did not destroy it entirely.

On passing this heater one day, I heard water rumbling inside, and desiring to know how much water was in the heater, I noted the height of the water in the sump well. Then I broke the vacuum and of course the heater drained itself, and a barrel of water drained out of it, which the vacuum had held, notwithstanding the open-ended ¾-in. vent pipe.

I wanted the owners to install a vacuum trap so as to drain the heater while maintaining a vacuum, but they delayed its purchase and I refused to take a chance running condensing with a feed-water heater nearly full of water. I would like to know how Mr. Cultra avoids this difficulty, and I wonder if he has ever noticed the sump well before and after breaking the vacuum. I think this method of running condensing is flirting with trouble, especially with a barrel of water in the feed-water heater and where the engine and heater are both on the same floor. Engines have been wrecked by drawing water that has accumulated in the exhaust pipe or heater into the cylinder, because the engine, after the throttle is closed, makes an excellent pump in such cases.

If Mr. Cultra had a vacuum trap in his system to drain the heater and to keep it drained, he would be taking fewer chances.

A. C. WALDRON.

Malden, Mass.

Starting a Steam Turbine

In the Jan. 25 issue of *Power*, page 144, there is a very interesting article on starting a steam turbine, written by W. Aspril. I agree with him on most points, especially, "Take your time." Invariably, instructions for starting a turbine tell you to start the circulating, hotwell and air pumps, and then, after the vacuum has been raised, to start the turbine turning slowly. In some cases these pumps are all driven by the same prime mover, in which event, of course, all must be started at the same time. Most of the later installations, however, have all pumps driven separately and the hotwell is usually a two-stage centrifugal pump, and I know of nothing harder on pumps of this design than running them without water, which one is bound to do if all auxiliaries are started at the same time.

Now would it not be good practice to start the hotwell pump after the turbine is turning and not run the pump dry fifteen or twenty minutes, as is required in many plants to raise the vacuum? I think the most important duty in starting is to make sure that the atmospheric valves are in working order. We consider this so important that each week the valves are tested and a note made on the log sheet, signed by the man doing the testing, Another thing of great importance is the emergency stop. It is safe to say that 90 per cent of the turbine failures are caused by emergency stops not being in working order. If a machine has been down for any length of time, the emergency speed device should be tripped by overspeeding or by adding weight to the emergency governor, and under no consideration should the machine be allowed to go on the line if it is not working properly.

I am glad that the manufacturers are beginning to co-operate with the operators to get a set of rules for the proper operation of the steam turbine. When this is done, it will go a long way toward eliminating turbine failures.

JOSEPH L. BROWN.

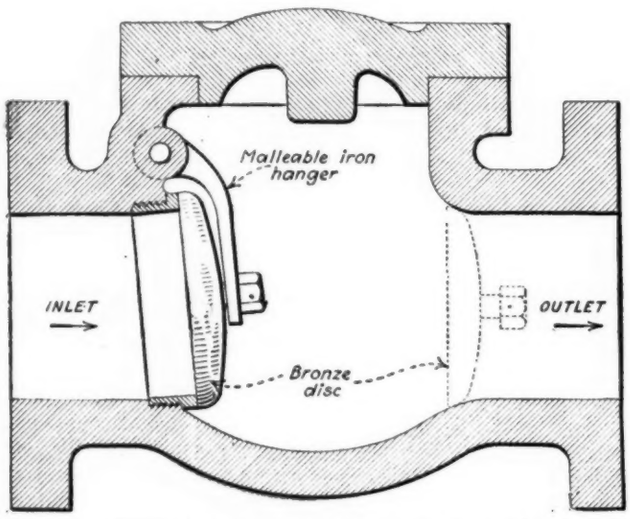
Louisville, Ky.

Simultaneous Breakdown of a Pair of Check Valves

When two separate mechanisms are alike in every particular, are made of the same materials, have the same dimensions and do the same amount of work, they may be expected to break down from wear and tear at about the same time. At any rate this is the conclusion that may be drawn from the behavior of a pair of swinging check valves in the 4-in. discharge lines from a pair of boiler-feed pumps. The pumps and check-valves were installed about ten years ago. Since that time the two pumps have alternated in boiler-feed service, week about.

One morning recently, after steam had been raised in the boilers, the engineer attempted to start one of the pumps. When he opened the throttle valve, the pump made three or four labored strokes and then settled down to a slow creeping movement, while water oozed from all the gasketed joints on the delivery end. Evidently, something was wrong, but as the water was low in the boilers, the engineer did not stop to investigate. Instead, he attempted to start the other pump, but he met with no better success than he had with the first one. When he opened the throttle valve, the second pump gave a duplication of the first one's performance.

By this time the water had fallen low in the boilers, so the engineer shut down the engine and banked the fires to keep the water from falling to a dangerously low stage. He then started a search for the cause of the difficulty. He closed the stop valve at



TYPE OF CHECK VALVE THAT FAILED
DOTTED OUTLINE SHOWS WHERE DISC LODGED

the boiler end of each feed line and opened up each of the boiler check valves. But these were found in working order. After he had spent considerable time in a fruitless search for the trouble in other portions of the feed lines, it occurred to him that the check valves at the pump end of the lines might be at fault. When he removed the caps from the bodies of these valves, the cause was apparent.

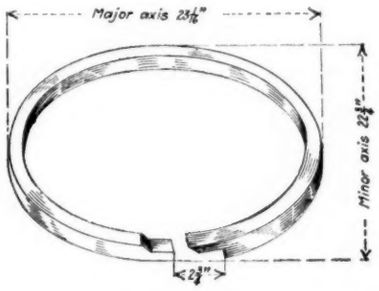
The valve discs and the studs and nuts by which they are hung are made of bronze. The hangers are of malleable iron. The details are shown in the drawing. Abrasion between the hangers and the retaining nuts, coupled with the corrosive action of the water, had gradually wasted away the ends of the hangers. Apparently, they failed simultaneously. Then, with the first surge of water from each pump, the liberated check was washed into the outlet orifice, as shown by the dotted outline of the disc, and there it stuck and obstructed the outlet.

A. J. DIXON.

St. Louis, Mo.

Oil-Engine Piston Rings

After several years of experience in the operation of Diesel engines I have become convinced that the usual piston-ring design is wrong. If the ring is turned circular with a diameter $\frac{1}{8}$-in. per foot larger than the



ELLIPTICAL DESIGN PISTON RING, SHOWING MAJOR AND MINOR AXES

working cylinder, when placed in the cylinder the ring will not be truly circular. For this reason a bearing will not be obtained all around the ring; gas will then blow through the clearances. This will cause carbonization of the rings and walls.

With a proper design of the ring a major and minor axis are chosen and the ring turned elliptical in shape. In the sketch of a ring for a cylinder having a diameter of 22.047 in. the major and minor axis diameters are as shown. When placed in the cylinder, the entire ring bears against the walls.

P. P. TALATZ.

Delhi Gate, India.

[In using a circular piston ring the engineer should file and scrape the ring until it bears at all points. This partly corrects the defect Mr. Talatz points out.—Editor.]

Removing Static Electricity from Belts By Application of Dressing

I have noticed several letters in *Power* relative to static electricity in belts and suggesting more or less complicated remedies. In my experience many of these cases are caused either by belt slippage, especially in dry cold weather, or else by iron railings in close proximity to the belts.

In the case of slipping I have known of the static being entirely relieved by a few applications of a belt dressing which will prevent slipping. In one case grounding combs had been installed without success, but applying belt dressing stopped the trouble at once. In the case of the iron railings a change in their proximity, if this can be conveniently done, will usually stop the trouble.

CHARLES N. TILLOTSON.

Boonton, N. J.

Protective Relays—Reverse-Power Type

Victor H. Todd, in an article on "Protective Relays—Reverse-Power Type," in the Nov. 2, 1920, issue of *Power*, on page 691, states: "As a result of several years' investigation it has been found that the method of connecting reverse-power relays with their potential coils in star, as has been the usual custom, is theoretically incorrect, and the relays may fail to operate upon the occurrence of the most common form of short-circuit."

For the last four or five years it has been the practice of the company I am with, to connect relays on our 25-cycle 9,000-volt system as shown in Fig. 6 of the article in question (reproduced here in Fig. 1) with this difference—that we use three potential transformers connected star-delta instead of two. I would like to know if Mr. Todd's statement as quoted in the foregoing includes the practice represented by the connection as shown in Fig. 2. B. G. JAMIESON.

Chicago, Ill.

[The following is the answer submitted by Mr. Todd. —Editor.]

Three potential transformers connected in star primary and delta secondary were used before the development of the connections which cause the current to lead the voltage by 30 deg., as explained in the original article. This star-delta connection with bus-voltage values given in Fig. 2 and 100:1 ratio transformers, will give two results at variance with standard practice: The voltage will be only about 52 instead of 110, and the current in any relay will be in phase with its voltage at 100 per cent power factor. The result is that on transmission lines having considerable inductance, especially on 60-cycle circuits, a short-circuit will cause the current to lag so far that there will not be sufficient energy to operate the reverse-power relays, and they may fail at the critical instant. However, this connection may give satisfactory results on small systems or on underground cable systems where the resistance is large compared to the inductance. In such cases most trouble starts between one cable and the lead sheath, so that if the neutral is grounded, the relays probably operate before the trouble involves more than one conductor.

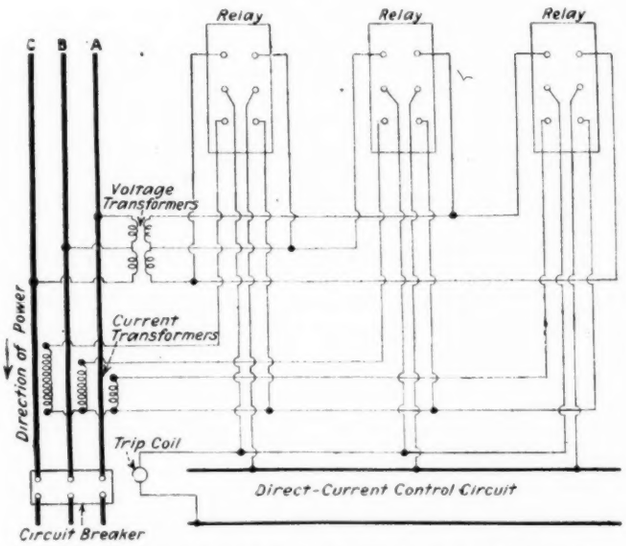


FIG. 1. CONNECTIONS OF RELAYS TO CAUSE THE CURRENT TO LEAD THE VOLTAGE ON NON-INDUCTIVE LOADS

Many of the larger companies are now using feeder reactors to some extent and are debating the question of using reactors in every feeder. Undoubtedly, the delta connections giving the current a 30-deg. lead will be essential whenever reactors are installed if the potential transformers are connected between the reactors and the busbars. VICTOR H. TODD.

Orange, N. J.

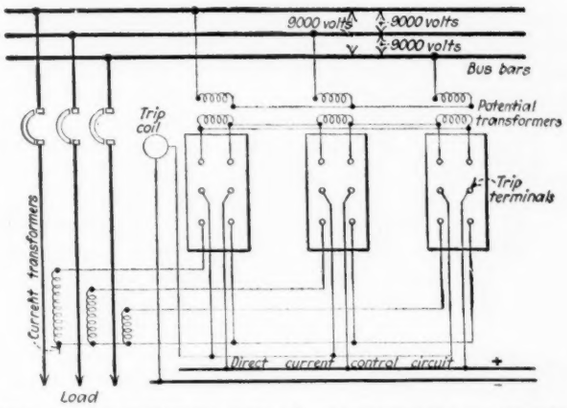


FIG. 2. STAR-DELTA RELAY CONNECTION, IN WHICH THE CURRENT IS IN PHASE WITH THE VOLTAGE AT 100 PER CENT LINE POWER FACTOR

Why Blame Caustic Soda for Boiler-Plate Cracks?

In the Dec. 7, 1920, issue of *Power* an article was published dealing with a boiler explosion in Finland, under the heading, "What Caused the Boiler Heads to Corrode?" No clear and distinct description of the corrosion itself, nor an analysis of the boiler feed water is given in the article. In other words, the main facts upon which a conclusion could be based as to the cause of the corrosion are missing. However, in the preamble of the article attention is called to the possible action of caustic soda on the shell and heads of the exploded drum and it is suggested that oxygen might have been liberated by the action of caustic soda, thus affecting the properties of the metal and producing brittleness.

According to the article the shell and the heads of the drum were corroded below the water line so deeply that only about one-tenth of an inch of pure metal was left. It is not stated, however, whether the corrosion extended over the whole area below the water line or whether it was restricted, as may be assumed, to parts between the varying water levels. Furthermore, no reference is made as to the location of the corrosion with respect to seams.

Whatever the area of the corrosion may have been, the description certainly does not point to an action caused by caustic soda or an alkaline substance generally, but more to corrosion caused by an acid, perhaps accelerated by oxygen dissolved in the water. Caustic soda and similar alkaline substances in concentrations as they occur in boilers do not cause corrosion; on the contrary, they are frequently and successfully used in preventing corrosion in boilers. The suggestion is made in the preamble that oxygen may have been liberated

by the action of caustic soda on iron, but no such chemical reaction is known. It has been determined that hydrogen, but not oxygen, is liberated when caustic soda in very high concentration is brought in contact with steel or iron at high temperatures. But in order to produce such results a concentration is necessary which is approximately twenty times as great as is usually recognized to be permissible in steam boilers according to the rules of good operating practice. Furthermore, before the concentration of the water inside a boiler departs appreciably from this permissible low limit, and long before it can ever reach the higher harmful concentrations, foaming unavoidably takes place and the operator is reminded to lower this concentration by blowing off to prevent the foaming from reaching so dangerous a degree that the boiler has to be shut down.

In a former contribution (*Power*, April 27, 1920) attention is called to the fact that the presence and the concentration of sodium salts in the boiler should at least be proved before they are blamed for failures. Reference was made to experiments which proved that brittleness and cracks in seams occur and can be produced at will in the absence of sodium salts by wrong mechanical and thermal treatment of the steel. Some further references, recently published, confirming these statements may be of interest.

If it is correct that hydrogen produced by the reaction between steel and an aqeous solution, occluded by steel and penetrating through steel, causes brittleness of the steel, then the amount of hydrogen penetrating the steel is to a certain degree at least an indicator of the brittleness. T. S. Fuller published in the "Transactions of the American Eletrochemical Society," 1919, Vol. 96, the results of his investigation regarding the penetration of iron by hydrogen. He found that the relative rate of penetration through electrolyzed iron was the same whether he used a 1 per cent sodium-hydroxide solution or common tap water. He also proved that tubes without any electrical connections immersed in water at 50 deg. C. and 90 deg. C. and in steam were penetrated by hydrogen and that the volume of hydrogen that penetrated through the tubes increased with the temperature. The results obtained by Mr. Fuller show that the presence of caustic soda in solution is not a necessity in producing hydrogen.

Messrs. Rosenhain and Hanson, in a paper, "Intercrystalline Fracture in Mild Steel," read before the Iron and Steel Institute at its autumn meeting, September, 1920, came to the conclusion that cracks in boiler plates and tubes show a striking resemblance to those found under certain conditions in a number of non-ferrous metals and alloys. The most familiar case of this kind is that generally known as "season cracking" in ordinary brass caused by mechanical and heat treatment. They also state that it has been clearly proved that corrosive action is not essential to the occurrence of intercrystalline cracking under the prolonged application of stress and that this action can only be regarded as a subsidiary and not a fundamental cause of the phenomena.

On Dec. 8, 1920, Prof. Albert E. White read a paper, "The Constitution and Properties of Boiler Tubes," before the American Society of Mechanical Engineers. He more particularly investigated one of the causes of tube failures from recrystallization. Recrystallization, according to Professor White, will occur if steel with a low carbon content which has previously been mechanically deformed at a temperature below the critical is later heated for a sufficient time to any temperature below that of the critical. He stated that mechanical deformation to some degree is unfortunately assured by present-day methods of handling tubes and the time and temperature conditions required for recrystallization are always present in boilers. He raised the question whether tubes with a higher carbon content would not insure longer life. In the discussion of this paper one of the speakers said that he had experienced one case where brittleness in the seams of boilers occurred in the absence of sodium salts in the boiler feed water.

In many cases of boiler failures, especially those where brittleness of the metal is assumed or determined, it has of late become customary to suggest caustic soda as the cause without venturing to prove its presence. The suggestion is based on the assumption that the presence of caustic soda is a necessity in producing brittleness, but as shown this assumption is not sustained by facts, because cracks and brittleness can be produced by wrong mechanical and thermal treatment in the absence of caustic soda.

It almost appears as if caustic soda is to play a rôle similar to that played by carbonic acid for so long a time before the real cause of corrosion in heaters, pipe lines, boilers and condensers was generally recognized. About ten to twelve years ago, it was a well established fact that corrosion and rusting in heaters, etc., was possible and occurred in the absence of carbonic acid. (See, for example, Cushman and Gardner, "Corrosion and Preservation of Iron and Steel," 1910, or Heyn and Bauer, "Attack Upon Iron by Water and Aqueous Solutions," 1908.) In the latter reference the statement is made that although it has been proved that the presence of carbonic acid is not a necessity in the rusting process, most of the textbooks continue to refer to the old myth "carbonic acid" when discussing the process of rusting. The consequence was that no attention was given and even today too little attention is paid to the oxygen, which is the main factor in the rusting process. As long as caustic soda is blamed for cracks and brittleness, although it has been proved that its presence is not necessary as a cause of such failures, the general public will not recognize the full importance of determining the real cause of the embrittling action and, as a consequence, the real offender will often be permitted to escape, just as oxygen escaped so long on account of the myth "carbonic acid."

In order to restrict boiler failures to a minimum it is necessary to know the fundamental causes of such failures, and therefore everything that can detract attention from the fundamental causes should be avoided. In order to understand clearly the actions that led to such failures much more investigation must be done, and therefore the suggestion made by Messrs. Rosenhain and Hanson at the end of the paper mentioned should be supported by all. This suggestion reads: "The whole matter is one which obviously requires much further investigation. For this purpose, in addition to laboratory experiments, the systematic and exhaustive examination of every case of cracking in boiler-plate steels would be of very special value." Careful operation and examination of steam boilers, periodical inspection by experts and calling in experts when any irregularities are observed have been recommended to users of steam boilers in order to prevent trouble caused by cracks and brittleness in boiler material.

New York City. H. KRIEGSHEIM.

INQUIRIES OF GENERAL INTEREST

Forward and Return Strokes—Which is the forward and which is the return stroke of a reciprocating engine? D. A.

As the piston leaves the head of the cylinder, it is said to be making its forward stroke, and the reverse motion is called the return stroke. The distinction can be fixed in the mind by remembering that with a trunk piston a power stroke is a forward stroke.

Foreign Gas in Refrigeration System—How can I determine if there are foreign gases in our refrigeration system? W. L. M.

If the capacity of the plant has dropped and the head pressure persists in keeping high, foreign gases are usually the cause. To detect such gases insert a hose connected to the condenser purge valve in a pail of water. The ammonia gas will be absorbed by the water, while any foreign gas will bubble. If inflammable the gas can be ignited with a match as it leaves the water.

Sizes of Pump Suction and Discharge Pipes—What should be the highest velocity of water in the suction and discharge pipes of a duplex pump? J. E. R.

The velocity in the suction pipe should not exceed 240 ft. per min. and in the discharge pipe 300 ft. per min. The pipe sizes approximately corresponding to these velocities are given by the formulas,

$$\textit{Suction diameter in inches} = \sqrt{0.1G}$$

$$\textit{Discharge diameter in inches} = \sqrt{0.08G}$$

where G is the number of gallons pumped per minute.

Dashpots of Corliss Engine—Why are dashpots used on the valve gear of a Corliss engine? J. G. S.

A dashpot plunger is suspended from an arm on the spindle of each steam admission valve to close the valve quickly and quietly after it is disengaged for effecting cutoff. In most forms, while the valve is opening a partial vacuum is obtained in the "vacuum chamber" of the dashpot by the upward movement of the plunger, and when the valve is released the fall of the plunger is accelerated by the pressure of the atmosphere. The "vacuum chamber" plunger has connected to it the piston or plunger of a "cushion chamber," or dashpot proper, in which an air cushion is provided to bring the plungers to rest without shock.

Load Distribution of Alternators in Parallel.—Do alternators in parallel change their speed, consequently the frequency, in changing their load distribution, or do they change only the relative position of the main field with respect to the armature field? H. G. S.

When changing the load distribution between them, alternators in parallel often change both their speed—consequently the frequency—and the relative magnetic positions of main and armature fields; but their relative speed remains the same, since they must remain in step. Thus, if it is desired to increase the proportion of load taken by one machine, the prime mover driving that machine is speeded up, the rotor of the generator jumps forward while that of the other generator drops back, with respect to their respective armature fields, and the first machine takes some of the load off the second, pulling it up to the new speed. The speed and frequency of the two machines have therefore increased. They may be kept constant, however, by a double adjustment of speed, raising it slightly on one machine and lowering it on the other.

Draft Affected by Direction of Wind—Does the direction of the wind have any influence on the way boilers steam? We have four boilers connected to a 110-ft. stack. Our boilers face the south, and when the wind is from the north it is harder to hold the steam. There are no hills or valleys to change the wind from its course? M. C.

The general trend and pressure of the atmosphere are greatest in direction of the wind and, other conditions being equal, there is somewhat lower supply of air and consequently a lower rate of combustion and generation of steam when the direction of the wind is away from the front of the boilers.

Selecting Scale of Indicator Spring—What determines the best scale of indicator spring for taking a diagram? L. L. S.

For most purposes it is desirable to use the lowest scale of spring and secure the highest diagram obtainable within the limits of vertical motion of the pencil and good operation of the instrument. Standard patterns of indicators provide for a pencil rise of 2 in. to 2½ in. above the atmosphere line, and the lowest scale of spring to be employed is found by dividing the initial pressure by the permissible rise in inches. If there is a waviness in the admission or expansion lines of the diagrams due to inertia of moving parts of the instrument, smoother, although lower, diagrams are obtainable by use of a higher scale of spring in the indicator.

Air Required for Burning Coal—How much air must be supplied to burn a pound of coal? H. L. B.

The air required for the combustion of a pound of coal is given approximately by the formula,

$$\textit{Weight of air in pounds} = 12\ C + 35\ \left(H - \frac{O}{8}\right)$$

in which C, H and O represent the parts of a pound of carbon, hydrogen and oxygen respectively in a pound of the coal. For perfect combustion most fuels combine with about 12 lb. of air per pound of the fuel. But in burning the fuel, to insure that each atom of carbon will meet with an abundance of oxygen for complete combustion, more air must be admitted to the furnace than is necessary for the combination. The weaker the draft the more excess air will be required for this purpose. With natural draft it is usual to provide for a supply of about 100 per cent excess air, and with forced draft about 50 per cent. As a pound of air at 62 deg. F. has a volume of 13.14 cu.ft., with natural draft the provision for air supply should be about $12 \times 2 \times 13.14 = 315$ cu.ft., and with forced draft about $12 \times 1.5 \times 13.14 = 236$ cu.ft. per pound of coal that is to be burned. Then, for best economy, the quantity of air actually supplied should be no more than required under the conditions for obtaining the highest percentage of CO_2 in the flue gases.

[Correspondents should sign their communications with full names and post office addresses.—Editor.]

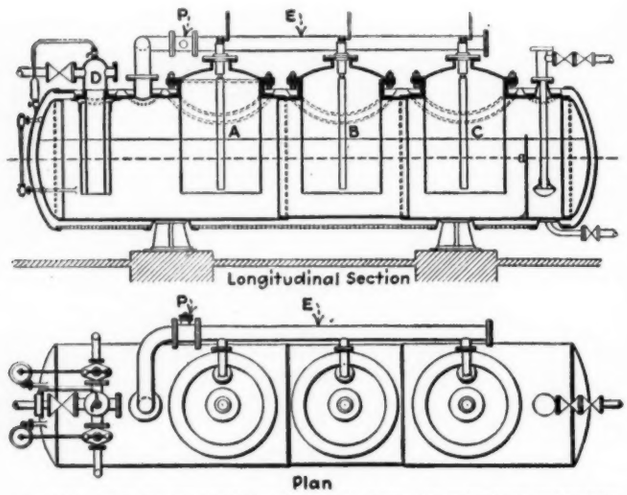
Electric Heating of Steam Boilers in France*

By G. A. MAILLET

ALTHOUGH the production of steam by electricity has been contemplated for some time, it is to be considered only when there is an excess of power available, as for instance, on hydro-electric systems at the time of high water or low load. Under these conditions energy that would otherwise be wasted may be purchased very cheaply.

The advantages claimed for electric heating of boilers are the low cost both for the boiler itself and for the installation, the saving of labor, the great reliability, low cost of repairs and the absence of smoke. Considering that the power utilized would otherwise be lost and in view of the exceedingly high price of coal, it can be seen that such a boiler would pay for itself in a very short time. Moreover, one must also take into consideration the many advantages of this latter method, which stands in about the same relation to the former as the electric motor does to the steam engine.

It was an Italian engineer, Revel, who made the first electric boilers on a commercial scale. This was done at the beginning of the war at the Bussi plant of the Societe Italiana di Elettro Chimica, where seven boilers, each of



PLAN AND ELEVATION OF 4,000-KW. ELECTRIC BOILER

600 kw. capacity, are supplied with three-phase current at 6,000 volts. This installation, which has been successfully operated for several years, uses the night power from the large central hydro-electric plant of Pescara, which supplies Naples.

Not only in Italy, where there are now several hundred in operation, has the use of this boiler been developed, but many are also in service in Switzerland and are giving very satisfactory results. Some of the leading manufacturers are giving considerable attention to this subject.

Although France has been backward in this respect, it is in the Franch Alps that the largest boilers of this kind are to be found. A large paper mill at Brignoud installed, in September, 1919, a trial boiler using nearly 2,000 kw. three-phase power at 6,500 volts, with three electrodes immersed in a large quantity of water. They placed an order the following January for two boilers, each capable of transforming 4,000 kw. into steam at a pressure of 85 lb. per sq.in. The first of these was put in operation about the first of May and the other shortly afterward. For two months these boilers supplied alone the steam necessary for the four paper machines, until low water made it necessary to use the oil-fired boilers once more. The electric boilers remained idle until the fall rains, but have been operating ever since at from 400 to 1,100 kw. during the day and over 4,000 during the night.

These boilers can be brought up to pressure in a half an hour, but on account of their size it is better to allow three hours. Once under pressure the power absorbed may be varied almost instantly between very wide limits. They adapt themselves remarkably to the unsteady conditions of a hydro-electric system, by virtue of the fact that each is in itself an accumulator. At Brignoud a machine may start or stop abruptly, or a digestor draw a sudden load of steam, without causing any great variations in the steam pressure. On the other hand, accidental interruptions of the current are not to be feared, for the power can be cut off for a half an hour without interfering with the operation of the paper machines or requiring assistance from the auxiliary boilers.

The policy of Italian and Swiss engineers has been to build small boilers and provide them with a separate accumulator for the storage of steam, for the sake of avoiding two difficulties—unequal expansion of the boiler plates and cracked insulators. The presence of cold water at the bottom of the boiler with water at steam temperature above it causes strains that have been known to develop leaks. This, however, can be avoided by heating the feed water or by using an automatic agitator. At first porcelain insulators were used, which gave some trouble from breakage, but with the development of a quartz insulator with a large factor of safety, there is now little to be feared from this cause.

French practice has been to combine the boiler and the accumulator as the operation under high voltages is much smoother. With the smaller boilers 6,000 volts is the maximum allowable, and should be used only when the water is very pure and with great care. Ordinarily, the boiler makers do not guarantee them except for voltages less than about 3,000. Above this they are obliged to use special devices. The large boilers at Brignoud, however, have always run with remarkable regularity even with the voltage at times of light load as high as 7,000. They are able to draw as much as 600 kw. per electrode, whereas for the small boilers 250 is the practical limit.

In view of the results obtained at Brignoud, the builders have taken steps to form a company to further as far as possible this kind of development.

Electric Boiler at Grenoble

The illustration shows a plan and a longitudinal section of the boiler which is now being built at Grenoble. A cylindrical steel drum incloses three evaporation chambers, *A*, *B* and *C*, suspended from the upper part of the shell, each chamber containing one electrode. Special patented quartz insulators insure perfect insulation and a steamtight joint. Steam leaves each chamber through a lateral tube, passes into a collector pipe *E* and through a valve *P* back into the drum. Steam leaves the drum through a separator and steam dome *D*. The boiler is equipped with the usual safety devices and is lagged with asbestos inclosed in polished sheet iron.

The operation is as follows: The boiler is first filled with water to a height found by experience to give sufficient surface of contact. The main switch is then closed, and as the circuit is closed through the water it soon reaches the boiling point. Moisture in the steam is removed by the separator as the steam passes through the dome. The rate of evaporation is controlled by means of the butterfly valve *P*, the partial closing of which causes an increase of pressure in the chambers *A*, *B* and *C*, forcing the water level down in those chambers. This decreases the surface of contact between the water and the electrode and causes the boiler to draw less current. By closing the valve *P*, the chambers can be entirely emptied and the production of steam stopped, although the main switch should be opened if the boiler is to be shut down for any length of time.

*Abstracted from *Chaleur et Industrie*, October, 1920, by C. F. Merriam. An article on electric heating for steam production in Switzerland, by E. T. Constam-Gull, was published in *Power*, Oct. 12, 1920, p. 596.

Boiler Inspection in Ohio

By C. O. Meyers*

Compulsory inspection of steam boilers became effective in the State of Ohio on Jan. 1, 1912, and was the direct result of an active campaign on the part of the stationary engineers. These men for years had been entrusted with the care and management of steam boilers and were directly responsible for their safe and economical operation, but were for various reasons unable to obtain the supplies or repairs necessary to secure best results toward safe operation. They took it upon themselves to bring together all the interests affected by compulsory boiler inspection and voluntarily financed the movement, with the result that today there is a boiler-inspection law in Ohio that is second to none. Purchasers of boilers in states where there are no boiler-inspection laws are specifying Ohio Standard when buying new boilers, knowing that thereby they will secure boilers that are right as far as material requirements and workmanship are concerned and that have been thoroughly inspected in the shop during construction by a qualified Ohio boiler inspector who is in no way interested in the manufacture or sale of such boilers.

Manufacturers of steam boilers for use in the State of Ohio are required to secure authority from the boiler-inspection department to build boilers and are given a facsimile of stamping to be placed on each boiler they construct in accordance with the Ohio law and rules. They are required to file with the department a manufacturer's data sheet for each Ohio standard boiler they build, giving all details of construction upon blanks furnished by the department, and certified to by a qualified Ohio inspector who made the shop inspections. The inspector is required to check up the plates before any work is started upon them and makes a record of the heat numbers, brand, tensile strength and quality of material, which he carefully checks with the mill test report; he makes another inspection after the rivet holes are made, to see if they meet the requirements of the law, and after the boiler is completed and is ready for testing, he makes his final inspection and witnesses the stamping of the Ohio standard facsimile upon the finished boiler.

All boiler inspectors are required to pass a rigid examination upon the construction, installation, inspection and operation of steam boilers and their appurtenances, before the Ohio Board of Boiler Rules, for which a fee of ten dollars is charged. To be eligible for this examination, the applicant is required to have had not less than five years' actual experience in an engine room, boiler room, boiler shop, or as a boiler inspector, or equivalent. The successful applicant is given a certificate of competency certifying that he has passed the required examination, but before he may legally make boiler inspections he must also secure a commission from the department authorizing him to make such inspections in accordance with the requirements of the Ohio boiler inspection law and rules. These boiler inspectors are divided into two classes: Those employed by the State of Ohio, who are called general inspectors and those employed by boiler-insurance companies authorized to do business in the State of Ohio, who are known as special inspectors. All boiler inspectors, however, are required to pass the same examination and work under the rules and regulations promulgated by the Ohio Board of Boiler Rules, and are further required to make reports of inspections to the department at Columbus, Ohio. The facsimile issued to a boiler manufacturer, as well as the commission issued to a boiler inspector, may be revoked at any time for incompetence, untrustworthiness or for wilful falsification of any matter or statement contained in any report of inspection; and it is found that boiler manufacturers and boiler inspectors place too high a value upon their authority to build boilers and inspect them to take any chance of having this authority revoked for any cause.

The Ohio Board of Boiler Rules consists of five members, one to represent each of the following interests: Boiler manufacturers; boiler-insurance companies; boiler users; operating engineers; the State, represented by the chief inspector of steam boilers, who acts as chairman and whose duty it is to enforce the rules and regulations of the board.

It is the duty of this board to formulate rules for the construction, installation, inspection and operation of steam boilers, for ascertaining the safe working pressure to be carried on them, for governing the quality of materials to be used in their construction, for regulating the size and construction of safety valves, fusible plugs and other appliances used in connection with their safe operation and for the examination of applicants for certificates of competency as inspectors of steam boilers.

There are fifty-seven shops in the State of Ohio and ninety-three in other states, a total of 150 shops, authorized to manufacture Ohio Standard boilers. There are 232 inspectors regularly qualified to make boiler inspections in accordance with the state requirements. About one-half of these inspectors reside in the various states where Ohio Standard boilers are built, are in the employ of boiler-insurance companies, and make the required shop inspections in those states.

*Chief deputy of the Industrial Commission of Ohio and secretary-treasurer of the National Board of Boiler and Pressure Vessel Inspectors

Power Applications to Cotton-Finishing Plants*

After noting the steam demand for processing and heating purposes in finishing plants as from two to four times that for power Mr. Loeb gave the following factors controlling the relation between them: (a) Type and economy of prime movers; (b) kind of cloth finished and nature of finishing process; (c) efficiency of the process machinery;

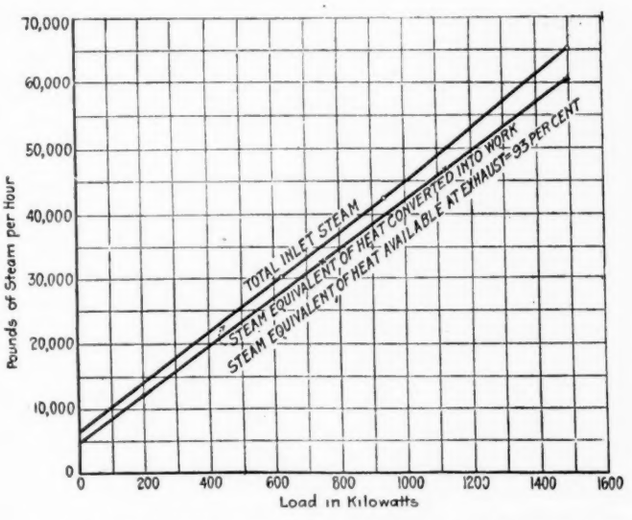


FIG. 1. STEAM CONSUMPTION AND AVAILABLE EXHAUST FROM A 1500-KW. NON-CONDENSING TURBO-GENERATOR

Steam pressure at throttle, 175 lb. per sq.in.; back pressure at exhaust, 12 lb. per sq.in.; steam flow at full load per hour, 65,000 lb.; equivalent steam available at exhaust, per hour, 60,600 lb.; inlet steam available at exhaust, 93 per cent.

(d) mean outside temperature; (e) skill and competency of master mechanic's department; (f) strictly local conditions.

Opinion as to the lowest feasible working steam pressure for process work is extremely varied. It has been found, however, that with ample heat-transfer surface pressures averaging about 12 lb. gage will take care of fully 80 per cent of all requirements.

Since, therefore, power may be generated as a byproduct at a cost representing merely the fuel equivalent of conversion and condensation, labor and material costs in at-

*Abstract of a paper by Leo Loeb, presented before the American Society of Mechanical Engineers Dec. 10, 1920.

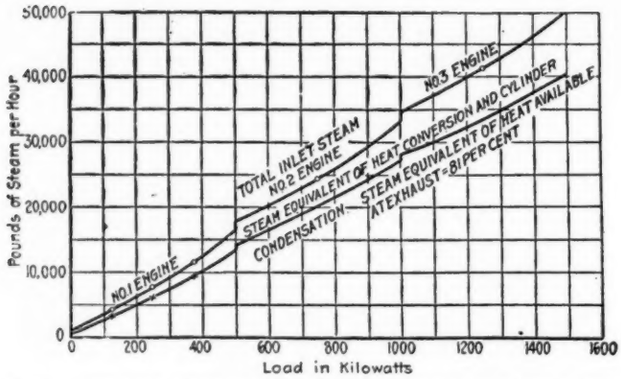

Pounds of Steam per Hour
Load in Kilowatts
TOTAL INLET STEAM NO.2 ENGINE
NO.3 ENGINE
STEAM EQUIVALENT OF HEAT CONVERSION AND CYLINDER CONDENSATION
STEAM EQUIVALENT OF HEAT AVAILABLE AT EXHAUST = 81 PER CENT
NO.1 ENGINE

FIG. 2. STEAM CONSUMPTION AND AVAILABLE EXHAUST FROM THREE 500-KW. NON-CONDENSING ENGINE GENERATORS

Steam pressure at throttle, 175 lb. per sq.in.; back pressure at exhaust, 12 lb. per sq.in.; steam flow at full load, per hour, 50,000 lb.; equivalent steam available at exhaust per hour, 40,600 lb.; inlet steam available at exhaust, 81 per cent.

tendance upon and maintenance of equipment, and fixed charges on power-plant machinery, the purchase of "outside power" is rarely advisable in fairly large installations. Water-tube boilers with from 150 to 200 lb. pressure

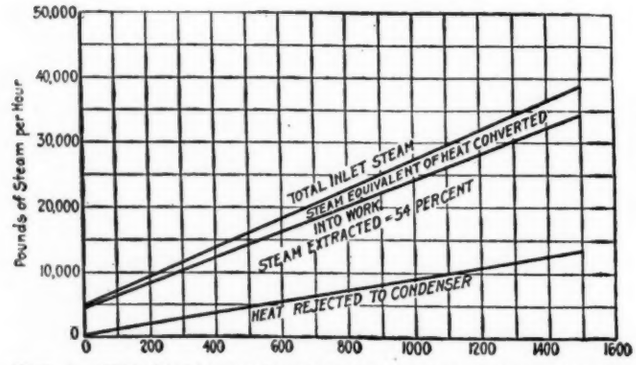

Pounds of Steam per Hour
TOTAL INLET STEAM
STEAM EQUIVALENT OF HEAT CONVERTED INTO WORK
STEAM EXTRACTED = 54 PERCENT
HEAT REJECTED TO CONDENSER

FIG. 3. STEAM CONSUMPTION AND AVAILABLE EXHAUST FROM 1,500-KW. EXTRACTION TURBO-GENERATOR

Steam pressure at throttle, 175 lb. per sq.in.; extraction pressure, 12 lb. per sq.in.; vacuum in condenser, 28 in.; steam flow at full load, per hour, 39,000 lb.; steam extracted at full load per hour, 27,000 lb.; inlet steam extracted, 69 per cent.

and a moderate degree of superheat are coming into general use, with soot blowers and feed-water regulators among items of minor equipment.

Mr. Loeb notes the tendency under present commercial

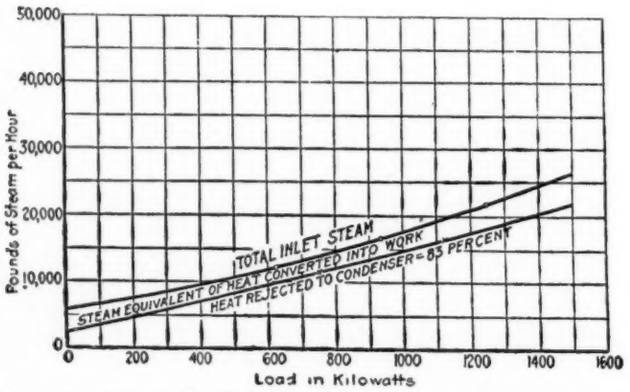

Pounds of Steam per Hour
Load in Kilowatts
TOTAL INLET STEAM
STEAM EQUIVALENT OF HEAT CONVERTED INTO WORK
HEAT REJECTED TO CONDENSER = 83 PERCENT

FIG. 4. STEAM CONSUMPTION OF A 1,500-KW. CONDENSING TURBO-GENERATOR

Steam pressure at throttle, 175 lb. per sq.in.; vacuum at exhaust, 28 in.; steam flow at full load per hour, 26,400 lb.; inlet steam rejected in circulating water, 83 per cent.

conditions toward bituminous coal, rather than anthracite, with oil as "the ideal fuel," but not to be adopted without coal-burning equipment in reserve, and refers to powdered coal as "just beginning to emerge from the experimental

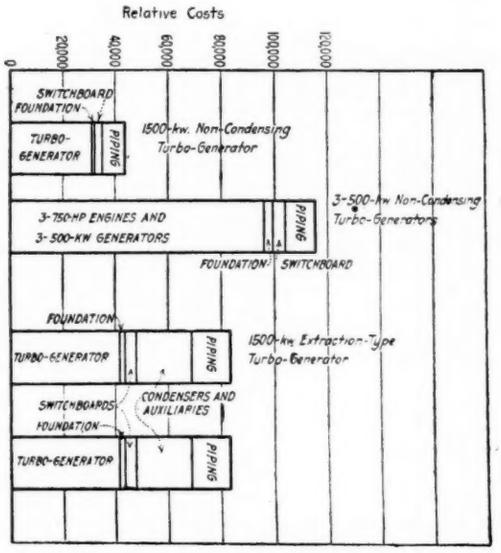


FIG. 5. RELATIVE INSTALLATION COSTS OF FOUR DIFFERENT TYPES OF PRIME MOVERS

stage" with some disadvantages offsetting the high combustion efficiency obtainable under favorable conditions.

After a discussion of various prime movers the author states that "steam power in the smaller mills may be developed in economical engines, but for plants requiring any

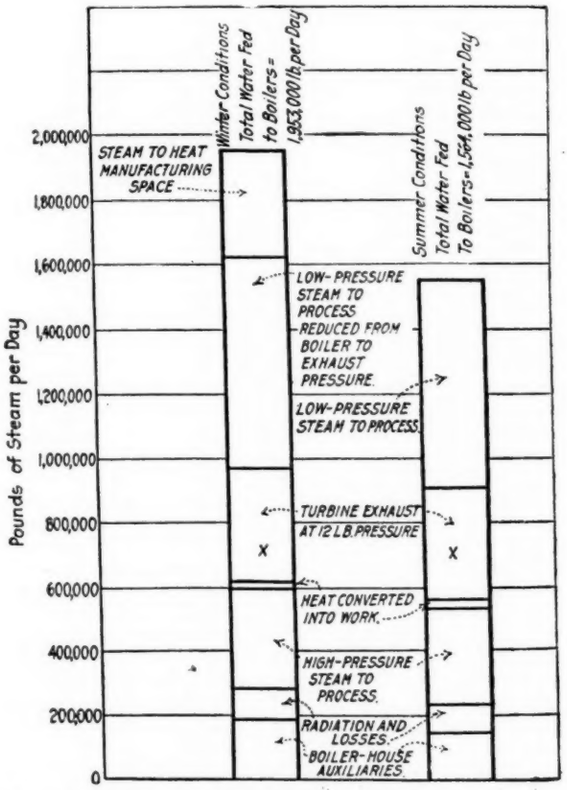

Pounds of Steam per Day
Winter Conditions Total Water Fed to Boilers = 1,953,000 lb. per Day
Summer Conditions Total Water Fed To Boilers = 1,564,000 lb. per Day
STEAM TO HEAT MANUFACTURING SPACE
LOW-PRESSURE STEAM TO PROCESS REDUCED FROM BOILER TO EXHAUST PRESSURE
LOW-PRESSURE STEAM TO PROCESS
TURBINE EXHAUST AT 12 LB. PRESSURE
HEAT CONVERTED INTO WORK
HIGH-PRESSURE STEAM TO PROCESS
RADIATION AND LOSSES
BOILER-HOUSE AUXILIARIES
X
X

FIG. 6 STEAM DISTRIBUTION (HEATING AN NON-HEATING SEASONS) FOR FINISHING PLANT WITH CORRECT HEAT BALANCE

X: Total high-pressure steam delivered to turbine.

considerable amounts of power the turbine drive from all points of view is preferable."

Figs. 1 to 4 show for prime movers of four different types the relative steam consumption per unit of output and the relative heat consumption under conditions where exhaust steam can be fully utilized at all seasons of the year. Assuming in each case that the primary drive is connected to an electric generator, the relative costs based on a 1,500-kw. size will be approximately as shown in Fig. 5.

Mr. Loeb emphasizes the tendency toward electric drives, both group and individual, and the necessity for a careful study of existing conditions in making a choice between a.c. and d.c. apparatus (or both) and of voltages, for variable speed applications, with a preference for motor generators as compared with rotary converters.

After a description of various motor-drives and auxiliary controlling and safety apparatus the paper concludes with a plea for care in maintaining thermal balance, citing an actual case as shown in Fig. 6 as correct for all seasons of the year.

Improving Load Factor

In discussing the paper, "Light, Heat and Power for the Metropolitan District of New York," presented before the New York Section of the American Society of Civil Engineers, Feb. 6, 1921, J. W. Lieb said in part:

In the Metropolitan District the yearly load factor (½ hour maximum) of the entire 25-cycle system has not varied over 2 per cent in the last five-year period, starting from 34.4 per cent in 1915, increasing to 36.6 per cent in 1917 and 34.2 per cent in 1920. The whole system load factor—25- and 60-cycle service combined—increased from 34.6 per cent in 1915 to 37.3 per cent in 1919 and 36.5 per cent in 1920, covering in the last year a maximum demand of approximately 400,000 kw. and an annual output of 1¼ billion kilowatt-hours. This includes the operation of a division of a trunk-line railroad, an extensive surface railroad and a subway-tunnel railroad.

It is true that some of the constituent allied companies have made more notable improvements in their local conditions of supply. In one case, owing to the expansion of industrial applications, a change was effected in load factor during the five-year period of from 28.9 per cent in 1915 to 41.4 per cent in 1920, and in another case of from 36.6 per cent in 1915 to 40.1 per cent in 1920.

While such improvements are possible, indicating either an expansion of the service to cover new applications or a change in the character of the territory from a residential or semicommercial to more pronounced industrial characteristics, the improvement of the load factor in an extended co-operative system, due to the absorption of internal diversities, is indeed a slow and uphill process.

Some ten years ago a careful investigation was made of the diversity factors between a large street, elevated and subway railroad system and two large lighting systems in different boroughs of the greater city, and in a total combined load of over 360,000-kw. a total diversity was indicated of 1 to 1.075, making a total difference in this case between the individual and joint maximum of about 25,000 kilowatts.

In analyzing the data on output and load factor of the largest generating systems in America in 1919, published by the *Electrical World*, it appears that the average annual load factor, weighted, of the largest 12 systems with steam generation was approximately 42 per cent, varying from 31.5 per cent to 47.5 per cent; and of 35 hydro-electric or mixed generating plants of approximately 57.5 per cent and varying from a minimum of 41.8 per cent to a maximum of 84.2 per cent, while the eight railway systems had an average load factor together of approximately 40 per cent. The 55 systems carrying a total maximum load of over 6,000,000 kw., with an annual output of over 27 billion kilowatt-hours had an average load factor of 50 per cent. It is found that smaller stations throughout the country with outputs of less than a million kw.-hours per year have load factors varying usually between 20 and 30 per cent.

It is well, therefore, to proceed somewhat cautiously as to the possibility of improved load factors and the advantage to be taken of diversity factors, which may be expected from the interconnection and linking-up of existing large systems. It will probably be found that each large system has already, through the internal exploitation of its own field, reached, not perhaps the maximum possible, but a characteristic load factor for its own territory, and an improvement of the combined load factor due to system diversities will only appear when the separate systems reach substantially different territorial load characteristics; that is, residential, commercial, industrial or mixed loads.

In the ordinary building plant emphasis, perhaps undue emphasis, has often been placed on the building-heating problem and the use of heat for auxiliary purposes, as a factor in determining the economic advantage of locally generated as compared with purchased power. It would, of course, be rash to make a sweeping statement that would apply to all cases, but an investigation covering many buildings, generally of a commercial character, indicates a net saving of coal where complete substitution of central-station service has been made over local-plant operation, amounting to approximately one-third of the total coal consumption.

One of the interesting and theoretically attractive phases of the private-plant problem in connection with central-station service is the suggested plan of a possible co-operative relation between the central-station and the isolated plant. The suggestion of shutting down private plants during the summer season when heat is not needed in the buildings and operating them only during the winter months when exhaust steam is needed for heating and the excess steam produced made available for local generation and possibly for feeding back into the street service, seems attractive at first, but on closer examination serious practical difficulties appear to interfere with its full realization.

This is particularly the case in the metropolitan district, where a maximum demand for building heat is made between five and nine o'clock in the morning and when the central-station could not advantageously utilize the surplus energy generated to produce the necessary exhaust steam; and on the other hand, the private plant is unable to generate enough byproduct energy to be of any service in contributing to meet the station peak coming between four and six o'clock in the afternoon.

To keep a considerable number of isolated plants shut down during the summer season, with the impossibility of starting them up instantly in case of thunder storms and excessive darkness, only aggravates the central-station problem of meeting these sudden and heavy emergency loads. For this reason and the fact that there is usually no excess surplus capacity available during the summer months, as already referred to, it would be necessary to provide additional station capacity to supply the installations shut down, and there would therefore be no saving in investment, especially as the service would require the same feeder investment as if the plants were permanently discontinued.

The fact that most of the private plants have 125-volt generators and would feed in on one side of the system only would also be likely to produce serious local unbalance and excess voltage, a thing to be feared in street service even with the modern tungsten lamps, where an overvoltage of even five or six volts will reduce the life of customers' lamps by one-half, causing urusual breakage and inconvenience to the public.

It is recognized, however, that some of these difficulties are local and due to weather and latitude conditions, but they are nevertheless real and must be considered where they are found to exist.

The one notable "prospect" which carries some hope of improving the system load factor, when developed, is the electric-vehicle business, particularly electric trucking, on account of the possibility of its expansion, its inherent high load factor and the naturally off-peak hours during the night for the battery charging.

As the result of the experiences of the Santa Fé Railroad it is claimed that the life of a boiler fired with coal is 10 per cent longer than that of an oil-fired boiler. The life of a boiler tube is decreased by 40 per cent if fuel oil is used.

Wear of Diesel Engine Parts*

By Geoffrey Porter, A.M., I.C.E.

Diesel engines, as do men, vary as to individual characteristics, and there is no method whereby the behavior of any particular engine can be foretold, but one can state with a fair degree of precision what they will do as a whole. For this reason values given as to wear may not apply to any one engine although being strictly true in general.

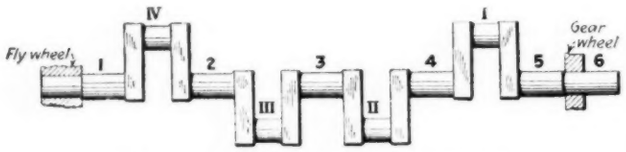
Cylinder Liners—From the measurements obtained from a number of engines it appears that in vertical engines the wear at the lower end of the liner is practically nil, increasing upward until it reaches its maximum value at a point corresponding to the top and upper dead-center position of the top piston ring.

It has been frequently stated that the wear will be at the rate of 0.001 in. per 1,000 hours of service. This statement is not borne out by the investigations made. The wear varies enormously; it appears that the rate of wear increases with the period of service. From a comparison of measurements from a number of engines it can be stated that the rate of wear per 1,000 hours of service at the point of maximum wear is about as shown in Table I.

TABLE I. CYLINDER WEAR

Length of Service in Hours	Rate of Wear in Thousandths of Inch per 1,000 Service Hours
4,000	2.8
16,000	2.3
21,000	2.8
25,000	3.5

These figures are by no means final and may not hold good for any other engines. Local conditions affect the wear



ILLUSTRATING CRANKSHAFT WEAR

such as the fit of the liner in the jacket, condition of the machined surface, character of lubrication, fit of piston and rings, amount of ash in the fuel oil, etc.

The permissible amount of wear will depend on the diameter of the cylinder. For cylinders below 18-in. in diameter 0.10 in. is about the maximum wear before replacement; for large cylinders 0.08 in. is as much as should be allowed.

Pistons—Apart from the effect of seizures pistons should not wear provided they do not suffer distortion or slackness of fit. If the piston becomes slack due to liner wear, it will wear considerably. Many seizures are caused by deformation as the result of heating. The greatest wear occurs in the piston-ring groove where the rate of wear often runs as high as 0.005 in. per 1,000 hours of service, although in some engines the groove wear did not exceed 0.05 in. after 20,000 hours of operation.

Piston Rings—Given a fuel oil yielding not more than 0.04 per cent abrasive ash, a suitable lubricant, average loading of 60 to 70 per cent of maximum cylinder rating and a piston speed of not over 800 ft. per min., the wear in piston rings of a vertical engine should not exceed 0.002 in. per 1,000 hours of service, with a wear in piston-ring width of less than 0.004 in.

Air Compressor Liners, Pistons and Rings—The wear is not so pronounced as in the main cylinder parts. The chief cause of wear is probably the side thrust of the connecting rod. The liner wear should not exceed 0.006 in. in 6,000 working hours.

Crankshafts — The subject of wear in crankpins has received considerable attention. In measuring a four-throw 6½-in. shaft, the average of three measurements was taken on each journal. Designating the parts as shown in the illustration, the No. 2 journal was found to be 0.0015 in. oval; No. 3 journal 0.0033 in. oval; No. 4 journal, 0.0011 in. oval; No. 5 journal 0.0007 in. oval and No. 6 journal, 0.0018 in. oval. This engine had been in service for 26,000 hours.

The same shaft was measured between the crank webs. It is very desirable while measuring the web that the weight of the piston and rods be allowed to rest on the pins. If not, the flywheel weight will tend to bend the shaft. The measurements obtained appear in Table II.

TABLE II. CRANK-WEB DISTORTION

Cranks	Distance Between Crank Webs, Inches 1	2	3	4
Top center	7.117	7.127	7.1245	7.123
Bottom	7.117	7.1265	7.1260	7.129
Difference	None	0.0005	0.0015	0.006

Gear Wheels—Considerable wear takes place in the gearing of the vertical governor and cam driveshaft. The wear gives rise to much noise in working and interferes with the proper operation of the valves. Endplay of the mainshaft is the cause of a major portion of this trouble. If the vertical shaft is not properly aligned, wear will naturally occur especially at the upper gear teeth.

Piston Pins—If the brasses are properly fitted and lubrication is sufficient, the piston-pin wear is inconsiderable. Wear of 0.006 in. in 2,500 hours of service is an average. The pins will keep in better condition if split brasses rather than solid shells are used. The brasses should be relieved at the sides and fitted metal to metal, no shims being used.

*Extract of a paper read before the Diesel Engine Users' Association, London.

Molecular Attractions of Contact

That an increasing smoothness of bearing surfaces reduces friction is well known, but that the smoothness can be carried to excess is not commonly understood. There is a definite critical point at which smoothness ceases to be a virtue and where molecular attraction or adhesion of surfaces starts to influence the friction to a greater extent than the shearing value of the minute projections and hollows.

With ordinary machined surfaces, such as are used for commercial machine bearings, the roughness prevents close enough contact for establishing any marked degree of molecular adhesion. The contacting areas are so small that the effect of cohesion is negligible. When the smoothness is increased to such a point, however, that from 25 to 50 per cent of the surface comes into actual metallic contact, then a peculiar phenomenon manifests itself. The faces suddenly "grip" each other with the quick snap characteristic of a vacuum cup, and instead of holding with a constant degree of tension, the holding force continually increases with the time until finally it will be found impossible to break the surfaces apart. The same effect takes place even with the surfaces covered with light oil, though of course the action is retarded by the length of time required for the expulsion of the oil film between the contacting surfaces.

That this is not due to atmospheric pressure may be easily proved: First, because the action takes place more rapidly in a vacuum than in open air, and secondly, for the reason that the pull required to separate two such surfaces of unit area is far greater than could be attained with an atmospheric pressure of 14.7 lb. per sq.in. Molecular adhesion is directly proportional to time and increases rather than decreases with the time of application for an indefinite period.

As an example, the Johannson leaf gages are ground within the limits of accuracy of plus or minus 0.00002 in. and, when in contact for a period of one hour, show an adhesiveness of over eleven atmospheres, or approximately 165 lb., per square inch. A similar experiment has often been demonstrated in the classroom by squeezing two clean-cut lead bullets into contact. If the surfaces are clean and true, it will be almost impossible to separate the two halves after they have been held together for five minutes or so.

It is therefore evident that we cannot obtain frictionless bearing operation by attaining perfection in the accurate finishing of surfaces. When losses due to surface roughness cease, far more powerful effects are exerted by molecular attraction. The fluid film still remains as the solution of the anti-friction problem regardless of the numberless attempts that have been made by manufacturers toward accurate machining.—*Scientific Lubrication.*

Washington News

Federal Power Commission Begins Issue of Permits and Licenses—Large Part of Calder Bill Eliminated—Muscle Shoals Appropriation Killed

By Paul Wooton
Washington Correspondent

Fifteen licenses and permits were authorized by the Federal Power Commission at its session Feb. 28. These are the first permits and licenses issued under the Act.

The Niagara Falls Power Co. was granted a license covering 19,500 cu.ft. of water per second, to be developed under the H. P. C. plan, that is, the diversion of the water above the Falls and returning it at the Maid of the Mist pool. The period of the license is fifty years. As a part of the consideration the company is to amortize completely its investment in Niagara plants Nos. 1 and 2 and hydraulic plant No. 2. This must be done during the period of the license and the investment completely written off the company's books. The question of valuation is left for subsequent determination.

The commission authorized the issuance of a preliminary permit to the lower Niagara River Power and Water Supply Co. for a period of two years, covering 30,000 sec.-ft. in the gorge.

A preliminary permit was granted to the Hydraulic Race Co. at Lockport. This permit covers a possible diversion of 500 cu.ft.-sec. through the barge canal, which is the amount that has been diverted heretofore under the authority granted by the War Department.

Seven other Niagara River applications were rejected, as follows:

Niagara Power and Development Co. for authority to utilize additional diversion in case it should be authorized by treaty. This was rejected on the ground that the commission cannot deal with possible future diversions.

Western New York Utility Co. for authority to divert an additional 500 second-feet.

Niagara, Lockport & Ontario Power Co. for additional diversion under an amended treaty. This application was rejected for the same reasons as in the case of the Niagara Power and Development Company.

The City of Buffalo's application was rejected because it specified no plans for development and because the commission is of the opinion that the city has no authority to carry out a scheme of development.

J. Kennard Thomson and Peter A. Porter's application was rejected because it comes within the jurisdiction of the International Joint Commission and because of the doubt of the feasibility of harnessing the Niagara River below the Falls.

The application of the Niagara Gorge Power Co. also was rejected, as was the application of Millard F. Bowen for a canal for navigation and power purposes, which would connect Lake Erie and Lake Ontario.

The commission went on record, by a unanimous vote, that, if there is to be additional diversion at Niagara Falls, the development should be "over the top" by carrying the water down to the vicinity of Lewiston so as to obtain the full head available.

Henry Ford & Son, Incorporated, is to be given a license for a development on the Hudson River at Troy, N. Y. Authority was granted to issue a license to the Southern California Edison Co. for an extension of its Big Creek system. Luther Hill is to be given a license covering a project of less than 100 hp. in California.

Preliminary permits were authorized as follows: Dixie Power Co., Arkansas; Washington Irrigation and Development Co., Washington; Pitt River Power Co., California; United Mills Co., North Carolina.

Licenses are to be issued for the following transmission lines as minor parts of projects: Southern California Edison Co., California; Coast Valleys Gas and Electric Co., California; Amazon-Dixie Mining Co., Idaho; Butte Jardine Metal Mining Co., Montana; Spanish Belt Silver Mining Co., Nevada; Paving Granite Quarry Co., South Dakota.

The remaining regulations, those numbered 11 to 20, were approved by the commission. The fact that no licenses or preliminary permits had been issued prior to this meeting of the commission was due to the fact that these regulations were controverted and their compilation had been necessarily delayed. It was brought out at the meeting of the commission that only two cases have been held up pending investigation. One of these was on the Deschutes River, where there is a conflict between irrigation and power development. A Federal investigation prior to action was requested by the State of Oregon. The other case is that of the Colorado River, where there is a similar conflict between irrigation and power development. A request for Federal investigation has been made by Wyoming, Colorado, Utah, Nevada and Arizona.

Applications received during the week ended Feb. 26 are as follows: The Ocklawaha Reclamation farms, Ocala, Florida, power project at Government lock, Ocklawaha river, Marion County, Fla., public utility; San Joaquin Light and Power Corporation, Fresno, Cal., reconstruction of dam, reservoir and power house, Kern River, Kern County, Cal., public utility.

Most of the original Calder coal bill, notably the provision for Government control during emergencies, was eliminated from the bill reported from the Committee on Manufactures, but this action was taken in the hope that legislation could be secured that would compel the coal operators and dealers to give the Government necessary statistical information.

The matter of some regulation of the coal industry has been brought to the point where it promises to be one of the live issues at the extra session of Congress. The sentiment in Congress for some such regulation is much stronger than had been anticipated, and it is expected that the Calder bill will be strongly pressed at the extra session. Senator Frelinghuysen, of New Jersey, however, has announced that he will bring up his Coal Commission bill, a measure which is considerably less drastic than that proposed by Senator Calder.

The $10,000,000 appropriation for the Wilson dam, proposed as a part of the Muscle Shoals development, has been stricken out of the Sundry Civil Appropriation bill by a vote of 193 to 182 in the House. The proponents of the measure made a stiff fight, but were finally defeated; the item, however, may be put through later on.

Boss—Is the *water tender* up in that boiler?
New Fireman—I dunno, sir; only this morning I heard the chief say the water was getting pretty hard ... in.

New Steam Station Planned

A new steam-electric plant is to be built by the Utica Gas and Electric Co., Utica, New York, to provide for its increasing power demands. The plant is to have an ultimate capacity of 37,500 kw., and its estimated cost is $1,750,000. Work is soon to be started and the first of the three 12,500-kw. units is expected to be ready for operation in about one year. Thomas E. Murray, Inc., of New York City, is responsible for the design of the plant, but the engineers of the Utica company will supervise its construction.

The site chosen for the new station, on a peninsula formed by a bend in the Mohawk River close to the terminal harbor channel and to the Barge Canal, is especially good for its condensing-water supply and its duplicate coaling facilities. It will be possible to receive coal by a short spur from the New York Central Railroad tracks or by barges in a slip excavated from the harbor channel. Between this slip and the boiler house will be a deep concrete coal pit over which will be the railroad track and a steel tower with electric hoisting equipment. It is estimated that the annual coal requirements will be 25,000 tons.

The building will be of brick, and the boilers, turbines, stacks, etc., will have steel foundations on concrete, supported by about 1,500 wooden piles. A 75-ton electric traveling crane will be provided for installation and repair work. There will be ten boilers of 13,730 ft. heating surface each, of which three will be put in at first to drive the first turbine-generator unit. Each turbine will be direct-connected to an a.c. generator and will have a speed of 1,875 revolutions per minute.

Obituary

Cecil P. Poole, author and editor in the fields of electrical and mechanical engineering, died recently at his home in Atlanta, Ga. His editorial career included service with the *Electrical World*, *American Electrician* and *Power*. In 1912 he become associated in engineering work with Lamar Lyndon, taking charge of the Atlanta office. The city claimed his service, however, and he established a department of inspection which, under his management, was attaining constantly increasing importance. Mr. Poole was a member of Aurora Grata Lodge F. and A. M., Brooklyn, N. Y., of the American Society of Mechanical Engineers and was a fellow of the American Institute of Electrical Engineers.

Personals

Ralph D. Mershon, consulting electrical and mechanical engineer, has moved his New York City office to 143 Liberty St.

J. P. Jollyman, of the Pacific Gas and Electric Co., has been made chief of the division of hydro-electric and transmission engineering of that company.

Allen E. Ransom, previously with the Westinghouse Electric and Manufacturing Co., is now superintendent of the Olympia Light and Power Co., Olympia, Wash.

J. H. Libbey, formerly electrical engineer for the Eastern Massachusetts Street Railway Co., Boston, Mass., is now with H. M. Haven and William W. Crosby, engineers and architects, Boston.

Rufus T. Strohm, who a few years ago was an associate editor of *Power*, has been elected assistant Dean of the faculty of the International Correspondence Schools after nearly 19 years in their service.

E. R. Fish, vice president of the Heine Boiler Co., lectured on Wednesday, Feb. 23, at the Case School of Engineering on the "Making of a Steam Boiler." The lecture was illustrated by moving pictures.

Chester H. Mannion, formerly in charge of the steam plant of The Nashua Manufacturing Co., Nashua, N. H., has accepted a position as chief engineer of the Petoskey Portland Cement Co., Petoskey, Mich.

Jacob M. Spitzglass, vice president and civil engineer of the Republic Flow Meters Co., Chicago, Ill., has been awarded the Edward Longstreth Medal of Merit by the Franklin Institute, Philadelphia, Pa.

H. C. Deffenbaugh has returned to his previous position as engineer and assistant to the secretary with the Empire State Gas and Electric Association. He was working last year on a survey of New York State water power.

V. V. Carmichael, formerly assistant power superintendent of the Aluminum Ore Co., East St. Louis, Ill., is now in the efficiency department of the Columbia Chemical Division of The Pittsburgh Plate Glass Co., Barberton, Ohio.

Carl C. Widener, former city engineer of Bozeman, Mont., and C. A. Truitt, formerly of Burns & McDonald of Kansas City, have associated as consulting engineers with offices in the New Commercial National Bank Building, Bozeman. Messrs. Truitt and Widener will specialize in municipal and hydraulic engineering.

Samuel B. Forse, who for years has been re-elected treasurer of the National Association of Stationary Engineers, has resigned as chief engineer and superintendent of the Standard Life Building and is now Examiner of Engineers for the Boiler Inspection Department of the City of Pittsburgh, Pa. Mr. Forse filled out a quarter of a century with the Standard and is succeeded by his son, Samuel B. Jr.

Society Affairs

Waterbury Section, A. S. M. E., will meet March 14 to hear C. C. Trump speak on "Pulverized Coal."

Toledo Section, A. S. M. E., will meet March 17 at the Toledo Railways and Light Co. George R. Lyons, of the Power Equipment Co., will give an illustrated lecture on "Distilled Boiler Feed Water."

The Engineers' License Law prepared by the North Carolina Assembly of the American Association of Engineers has been passed by the State legislature and now goes to the governor for signature.

The Association of Iron and Steel Electrical Engineers is to hold a meeting March 14, at which W. E. Thau, of the Westinghouse Electric and Manufacturing Co., will speak on "Electric Propulsion of Ships."

The American Association of Refrigeration is to hold its tenth annual meeting March 25 and 26 in the New Willard Hotel, Washington, D. C. The meeting will be important, as plans are to be discussed for reorganizing the society as a federation.

Engineers Interested in Lubrication held a meeting at the Machinery Club, New York City, on Feb. 24 to discuss the formation of a New York section of the American Society of Lubrication Engineers. Definite action was postponed for several weeks. Those interested should communicate with L. F. Lynes, 39 Cortland St., New York City.

The Boston Society of Civil Engineers, the A. S. M. E. and the A. I. E. E. are to hold the twelfth annual engineers' dinner at the City Club at 6:15, March 9. Edward J. Mehren, editor of *Engineering News-Record*, will discuss "An Engineer's View of Economic Conditions in Europe," and the Rev. McIlvar H. Lichliter, of the Central Congregational Church, Newtonville, will speak on "The Vaudeville Mind."

Miscellaneous News

An Electrical Laboratory in which it will be possible to develop 1,500,000 volts is being built by the Westinghouse Co.

The Greek Government recently employed a Swiss engineer to make a survey of water power in the State of Macedonia. After looking things over, the engineer estimated the total available power from five falls in the district to be about 350,000 hp.

The Largest Motor-Driven Passenger Liner yet projected is being built for the Swedish-North America Line, according to *The Review*, Paris. The vessel is to be driven by engines having a total of 16,000 indicated horsepower, at an estimated speed of 18 knots.

Pratt Institute, Brooklyn, N. Y., is to hold its annual "Vistors' Night" from 7:30 to 9:30 o'clock on March 10, when the school's shops, laboratories and drawing rooms will be open to the public. Some of the courses taught cover practical electricity, stationary steam engineering, power-plant operation and internal-combustion engine work.

The Distillation of Coal as a means of reducing national waste is strongly urged in a statement recently issued through Walter N. Polakov, chairman of the A. S. M. E. Fuel Section. Mr. Polakov states that if the 400 million tons of coal annually burned raw in this country were distilled there would be obtained 1,200,000,000,000 cu.ft. of fuel gas, 4,000,000 tons of ammonia sulphate, 1,000,000,000 gal. of crude benzol, 3,600,000,000 gal. of tar and 288,000,000 tons of artificial anthracite, resulting in a saving to the country of $2,000,000,000.

A Centennial of Peruvian Independence is to be held this year, acoerding to Eduardo Higginson, consul-general of Peru. The Peruvian government has recently voted approximately $3,000,000 for this purpose and has also arranged an exhibit of manufactures of other countries in connection with the Centennial. This latter feature should prove interesting to American manufacturers in search of South American trade. Information relative to rentals and assignment of space may be had from the Peruvian Centennial Exhibits Co., 42 Broadway, New York City, and A. Smemraldi, Lima, Peru, to whom the Peruvian government has granted concessions.

Business Items

The Fitzgibbons Boiler Co. has moved its office from the temporary quarters at 1181 Broadway to the former location at 17 Battery Place, New York City.

The Power Manufacturing Co., of Marion, Ohio, builder of "Primm" heavy-duty oil engines, has established a New York office in charge of H. L. Dean at 114 Liberty St., Room 1002.

The Burnoil Engine Co., South Bend, Ind., has been taken over by the Dodge Manufacturing Co.; all matters concerning the sale of its products are now handled by the Oil Engine Division, Dodge Sales and Engineering Co., Mishawaka, Ind.

The Nashua Machine Co., Nashua, N. H., whose factory burned down Dec. 31, 1920, has been reorganized as the Nashua Machine Co., Inc. A larger plant has been purchased and is being equipped to turn out the company's product, the Bundy steam trap.

Elliott Co., Jeannette, Pa., has made the following changes in its organization: W. A. Darrow, previously district sales manager of the Philadelphia office, is now special representative with headquarters in Philadelphia; F. F. Crawford, formerly St. Louis district sales manager, has been transferred to the Philadelphia office in the same capacity; C. L. Draper, previously with the Kansas City office, has become district sales manager of the St. Louis office; and M. C. Sickels, of the Cleveland office, has succeeded D. S. Tucker as Cleveland district sales manager.

FUEL PRICES

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run basis, f.o.b. mines):

Coal	Market Quoted	Feb. 22, 1921	Feb. 29, 1921
Pocahontas,	Columbus	$3.50	$3.50
Clearfield,	Boston	2.95	2.15@3.00
Somerset,	Boston	2.95	2.50@3.75
Pittsburgh,	Pittsburgh	2.20@2.50	2.25@2.50
Kanawha,	Columbus	2.60	2.50
Hocking,	Columbus	2.25	2.25
Pittsburgh No. 8	Cleveland	2.25@2.50	2.25@2.50
Franklin, Ill.,	Chicago	2.25@3.25	2.25@3.25
Central, Ill.,	Chicago	1.50@2.25	1.50@2.25
Ind. 4th vein,	Chicago	1.85@2.50	2.50@2.75
Standard,	St. Louis	1.90@2.00	1.90@2.00
West Ky.,	Louisville	2.00@2.25	2.00@2.50
Big Seam,	Birmingham	2.95@3.25	2.90@3.25
S. E. Ky.,	Louisville	2.50@3.00	2.50@3.00

DIESEL FUEL OIL

Chicago—24@28 deg. Baumé, $1.10@$1.20 per bbl.; 32@34 deg., 3¼@4¼ c. per gal.

Cincinnati—In 8,000-gal. tank cars; 26@28 deg., 9¼ c. per gal., 30@34 deg., 10c.

Philadelphia—26@28 deg. fuel oil, 8½c. per gal.; 30@34 deg. gas oil, 10½c.; 16@20 deg. boiler oil, 6c.

St. Louis—Base plus freight; group 3 24@26 deg., $1.10@$1.25 per bbl.; 26@28 deg., $1.20@$1.35; 28@30 deg., $1.30@$1.45; 30@32 deg.,$1.40@$1.55; 32@34 deg., $1.50@$1.65. No market for 16@20 deg. Baumé boiler oil.

New Construction

PROPOSED WORK

Me., Portland—The St. Joseph Roman Catholic Parish, 605 Stephens Ave., had plans revised for a 4 story convent addition at Deering Pl. About $250,000. O'Connell & Shaw, 18 Boylston St., Boston, Archts.

N. H., Litchfield (Thorntons Ferry P. O.)—The Moores Fall Power Co., c/o W. M. Parker, Pres., Manchester Natl. Bank, Manchester, plans to construct a dam and hydro electric power plant along the Merrimac River here.

Mass., Boston—The Amer. Mutual Liability Insurance Co., 245 State St., plans to build an office building on Beacon St. About $500,000.

Mass., Boston—The Amer. Sugar Refining Co., Granite St., had plans prepared for a 1 story refinery. Plans include 3 valve houses and alterations to the boiler room. About $13,000.

Mass., Cambridge—The Chauncey Real Estate Trust, c/o Dow, Harlow & Kimball, Archts., 101 Tremont Ave., Boston, will soon receive bids for a 4 story, 50 x 170 ft. apartment house including a steam heating system on Howard Sq. About $200,000.

Mass., Fall River—The City Hospital Comn. is having plans prepared for a 2 story hospital on Bedford St. About $700,000. E. M. Corbett, 70 Bedford St., Archt.

Mass., Lowell—A. J. Ryan, Archt., 85 Merrimack St., is preparing plans for a 3 story, 100 x 165 ft. apartment house at Tyler Park. About $225,000. Owner's name withheld.

Mass., Norwood—E. C. Brown & Co., Engr., 220 Devonshire St., Boston, will soon award the contract for a 133 x 300 ft. power plant for the Holliston Mills Co., Lenox Ave. One 150 kw. unit and two 200 hp. boilers, a 75 kw. motor generator set, etc. will be installed in same. About $200,000.

Mass., Winthrop (Boston P. O.)—The town is having plans prepared for a 3 story, 100 x 120 ft. high school including a steam heating system on Pauline St. About $150,000. W. M. Bacon, 27 Kilby St., Boston, Archt.

R. I., North Providence (Providence P. O.)—The Franciscan Missionaries of Mary, c/o T. S. McLaughlin, Archt., Union Trust Bldg., Providence, will soon award the contract for a group of convent buildings including a 2 story, 30 x 75 ft. boiler house, etc. on Fruit Hill Ave. About $400,000.

R. I., Providence—The Church of the Blessed Sacrament, 171 Academy Ave., is having plans prepared for a 2 story school on Regent Ave. About $300,000. Maginnis & Walsh, 10 Boylston St., Boston, Archts.

R. I., Providence—The Church of the Mediator Universalist plans to build a 1 story church on Elmwood Ave. About $225,000.

R. I., Providence—The Rhode Island Co., Union Depot, plans to remodel its power plant on Manchester St. About $500,000.

Conn., Bridgeport—The Sts. Cyril & Methodius Church, Church St., is having plans prepared for a 4 story school and hall. About $200,000. Bruno Wazny, 94 State St., Springfield, Mass., Archt.

Conn., Danbury—The city is having preliminary plans prepared for a 3 story, 200 x 225 ft. high school. About $500,000. Sunderland & Watson, 248 Main St., Archts.

Conn., East Hartford (Hartford P. O.)—The School Bd. had plans prepared for a 2 story, 62 x 166 ft. school. About $150,000. W. D. Johnson & Co., 174 Bond St., Archt.

Conn., Hartford—The Abraham Jacobi Hospital, c/o M. Goldenthal, Chn., 18 Asylum St., is having plans prepared for a 2 story hospital on Westland St. About $150,000. Berenson & Moses, 1026 Main St., Archts.

Conn., Hartford—The Bushnell Memorial Hall Assn., 108 Gillett St., is having plans prepared for a 1 story auditorium on Trinity St. About $500,000. Helme & Corbett, 190 Montague St., Brooklyn, Archts. Noted Nov. 2.

Conn., Hartford—The Newington Metal Goods Co., 284 Asylum St., is in the market for a 2nd hand single action power press to correspond with a No. 4 or 5 Farrel Foundry Power press.

Conn., New Milford—Conterbury School, Main St., had preliminary plans prepared for 4 buildings including a chapel, gymnasium, dormitory and classroom building. About $200,000. R. Hume, 2 West 47th St., New York City, Archt.

Conn., Torrington—W. E. Hunt, Archt., 197 Water St., will receive bids until March 21 for a 2 story, 106 x 143 ft. gymnasium including a steam heating system on Prospect St., for the Y. M. C. A., 113 Main St. About $175,000.

N. Y., Brooklyn—J. Lubroth, Archt. and Engr., 44 Court St. is preparing plans for two 4 story, 70 x 100 ft. apartment houses including steam heating systems on Howard Ave. near Blake Ave. About $200,000. Owners' name withheld.

N. Y., Brooklyn—The Pub. Service Comn., 49 Lafayette St., New York City, will soon award the contract for a signal tower and compressor room in the Livonia Ave. Yard, here.

N. Y., Buffalo—Canisius College plans to build a group of buildings including a power house on Main St., Hughes Ave. and Jefferson Ave. About $1,000,000. M. J. Ahern, S. J., Pres.

N. Y., Corning—The Corning Glass Wks., Walnut St., has awarded the contract for a power plant to Dwight P. Robinson, 125 East 46th St., New York City, at $250,000.

N. Y., New York—L. M. Blumstein, 230 West 125th St., plans to build a 5 story department store addition including a steam heating system at 236 West 125th St. About $1,000,000. R. D. Kohn, 56 West 45th St., Archt. and Engr.

N. Y., New York—Haring & Blumenthal, 1600 Bway, plans to build a theatre including a steam heating system on Brown Pl., Brook Ave. and 137th St. About $400,000. Architect not selected.

N. Y., Utica—The city plans to build a 2 story, 62 x 184 ft. addition to school on Jay St., $230,000. W. G. Frank, Clarendon Bldg., Archt. and a 2 story, 66 x 97 ft. addition to school at 1515 Brinkerhoff Ave., $150,000. F. H. Gouge, 70 Genesee St., Archt.

N. J., Atlantic City—The Atlantic City Electric Co., Arnold Bldg., plans to build an addition to its electric plant and install 10,000 kw. turbine. About $800,000. Architect not selected.

N. J., Morris Plains—F. H. Bent, State Archt., 142 West State St., Trenton, will receive bids until March 22 for a 4 story, 127 x 341 ft. psychiatric building at the Insane Asylum, here. About $800,000.

Pa., Erie—Thayer & Johnson, Archts., 5716 Euclid Ave., Cleveland, will receive bids until March 14 for a 3 story, 50 x 200 ft. theatre for A. P. Wesckler. About $200,000.

Pa., Monessen—The Bd. Educ. will soon award the contract for a 2 story, 136 x 200 ft. junior high school on 6th and Knox Sts. About $600,000. J. Merwin Beal, Archt.

Pa., Philadelphia—The Knights of Columbus, 1338 Girard St., plan to build a home and club building on Broad and Carlisle Sts. About $1,000,000.

Md., Baltimore—Israel Silberstein, Equitable Bldg., plans to build an 8 story, 60 x 115 ft. apartment house on Eutaw Pl. and Brooks Lane. About $500,000. G. R. Callis Jr., Amer. Bldg., Archt.

Md., Baltimore—The Loyola Roman Catholic College plans to build a 1 and 2 story, 80 x 150 ft. college on the Guilford Development. About $150,000. Maginnis & Walsh, 100 Boyleston St., Boston, Mass., Archts.

Md., Baltimore—The Memorial Hospital, Division near Mosher St., is having plans prepared for a 6 story hospital including a steam heating system on Guilford Ave. and 33rd St. About $750,000. J. E. Sperry, Calvert Bldg., Archt.

W. Va., Charleston—The United Mine Workers of America, Dist. 17, plans to build a hospital on Virginia St., here. About $500,000. Mills & Millspaugh, 67 East Long St., Columbus, O., Archts.

N. C., Ayden—The Free Will Baptist Denomination plans to build a college. About $300,000. J. C. Sawyer, Chn. of Bldg. Comn.

N. C., Charlotte—The Rankins Apartments Inc. plans to build an 8 story apartment house on East Ave. About $1,000,000.

N. C., Durham—Trinity College had plans prepared for a memorial building on West Main St. About $210,000. T. W. Seers, 1424 West Walnut St., Philadelphia, Pa., Archt.

N. C., Lenoir—The city plans an election to vote on $200,000 bonds to construct a high school.

Fla., Miami—A company organized by Avery C. Smith plans to build a tourist hotel. About $200,000.

La., New Orleans—The Roman Catholic Diocese plans to build a seminary building. About $1,000,000. Archbishop Snow, Bishop of Diocese.

Tenn., Nashville—The Tennessee State Memorial Comn., plans to construct a soldiers' memorial and capitol annex on Capitol Blvd. About $2,000,000. Archt. not selected.

Ky., Louisville—The Louisville Planing Mill Co., Beech and Woodland Sts., is in the market for one 8 x 14 x 14 in. noiseless cast iron tee and one 14 in. noiseless cast iron back pressure valve with companion flanges.

O., Akron—The Anshe Emeth Congregation will receive bids about April 15 for a synagogue between South Portage Path and West Market St. About $125,000. Swirsky & Miller, Herberich Bldg., Archts.

O., Akron—The Portage Constr. Co., 600 Herberich Bldg., plans to build an 8 story, apartment hotel on Bowery St. About $1,500,000. Swirsky & Miller, Archts.

O., Brookville—The Bd. Educ. will receive bids until March 26 for a 2 story high school. About $200,000. Pretzinger & Musselman, 1155 Reibold Bldg., Dayton, Archts.

O., Cincinnati—The Keneseth Israel Congregation, Rockdale and Washington Aves., is having plans prepared for a 2 story, 75 x 100 ft. church including a low pressure steam heating system. About $140,000. Harry M. Price, 709 Mer. Lib. Bldg., Archt.

O., Cincinnati—The Trustees Home of the Friendless, 433 West Court St., will soon award the contract for a 3 story, 40 x 200 ft. institutional building including a direct and indirect heating system, on Reading Rd. and June St. About $250,000. Harry Hake and Charles Kuck, Telephone Bldg., Archts.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., received bids for a 2 story, 104 x 249 ft. school on Euclid Ave. near Burgers Rd., from the Complete Constr. Co., 3209 Scranton Rd., $178,000; Alexander Bros., Williamson Bldg., $180,000; Drummond Miller, 4500 Euclid Ave., $186,800.

O., Cleveland—The Cleveland Hospital Assn., c/a J. T. Thomas, Pres., 2406 East 40th St., plans to build a 3 story negro hospital. About $200,000.

O., Cleveland—B. Lederman, 10709 Pasadena Ave., will soon award the contract for an 8 story, 60 x 255 ft. apartment hotel at 2026 East 107th St. About $500,000. M. Weiss, 618 Union Bldg., Archt.

O., Cleveland—K. L. Queisser, Schofield Bldg., plans to build a 2 story commercial and theatre building on Coventry Rd. About $200,000.

O., Cleveland—St. Stanislaus Church, 3649 East 65th St., will soon award the contract for a 3 story, 78 x 162 ft. school on East 65th St. About $150,000. Rev. Krzycki, pastor. W. C. Jansen, Electric Bldg., Archt.

O., Cleveland Heights (Warrensville P. O.)—B. R. Deming & Co., Fairmount Blvd., plans to build a 4 story apartment house on Cedar Rd. and Fairmount Blvd. About $250,000. Howell & Thomas, 4500 Euclid Ave., Cleveland, Archts.

O., Columbus—The City Natl. Bank, Gay and High Sts., plans to build a 5 to 8 story, 97 x 187½ ft. bank and office building on East Gay St. About $450,000. Stripling & Lum, 85 North High St., Archts.

O., Dayton—The Third Natl. Bank, 21 East 3rd St., is having sketches prepared for a 14 story, 115 x 192 ft. bank and office building on North Main St. About $1,500,000.

O., Ironton—F. A. Ross, clk., will receive bids about March 30 for a 2 story, 250 x 310 ft. school for the Bd. Educ. About $500,000. F. L. Packard, New Hayden Bldg., Archt.

O., Lakeview—The village is having plans prepared for a pumping plant, etc. About $70,000. Jennings & Lawrence Co., Hartman Bldg., Engrs.

O., Middletown — The Middletown Hotel Co. is having sketches prepared for a 7 story hotel on Main St. About $500,000. F. L. Packard, New Hayden Bldg., Archt.

O., Youngstown—L. W. Ritzi, 1726 Market St., plans to build a 3 story, 60 x 125 ft. store and apartment building on Market St. About $200,000.

O., Youngstown — C. Scheible will soon receive bids for water mains and additional pumps at the main plant, for the city. About $650,000. G. F. Turner, City Hall, Engr.

Ind., Carmel—S. A. Hodgin, trustee, will soon award the contract for a 2 story, 125 x 150 ft. school including a steam heating system, pump and air tank, etc. About $150,000. Layton Allen, 401 Lombard St., Indianapolis, Archt.

Ind., Indianapolis—The Bd. of Wks. plans to remodel 2 story market house on East Market St. About $125,000. Bass, Knowlton & Graham, 8th Hume Mansur Bldg., Archts.

Ind., Indianapolis—The Byram Realty Co. plans to build a 3 story, 96 x 103 ft. apartment house on North Illinois St. About $225,000.

Ind., Indianapolis—The Wentworth Realty Co. plans to build a 3 story, 106 x 297 ft. apartment house on North Meridian St. About $220,000.

Ind., LaPorte—The Princess Theatre Co. is having preliminary sketches prepared for a 3 story, 125 x 200 ft. hotel and theatre building including a steam heating system. About $275,000. H. L. Newhouse, 4630 Prairie Ave., Chicago, Ill., Archt.

Ind., South Bend — The Palace Theatre Co. plans to build a theatre. About $900,000. Architect not selected.

Mich., Lansing—The State Capitol is having preliminary plans prepared for a power plant and distribution system. The ultimate capacity of the station will be 55,000 kw. About $5,000,000. Woodwell & Resler, 501 5th Ave., New York City, Consult. Engrs.

Ill., Chicago — Englewood Business College, 6233 South Halsted St., will soon award the contract for a 3 story, 80 x 124 ft. business college including a steam heating system at 735 Englewood Ave. About $150,000. Worthman & Steinbeck, 155 North Clark St., Archts.

Ill., Chicago—The Mizpah Congregation, c/o Maurice Spitzer, Archt., 5 North La Salle St., plans to build a 1 story, 105 x 165 ft. synagogue including a steam heating system on Ashland and Morse Aves. About $500,000.

Ill., Chicago—The Roseland State Theatre, c/o Van Etten Bros., 1055 South Michigan Ave., is having plans prepared for a 3 story, 100 x 190 ft. theatre including a steam heating system on 110th Pl. and Michigan Ave. About $500,000. Jones, Linick & Schaefer, 336 South State St., Lessee.

Ill., Chicago—M. Sugarman, c/o Rissman & Hirschfield, Archts., 139 North Clark St., will soon award the contract for a 3 story, 80 x 125 ft. apartment house including a steam heating system on Lawrence and Springfield Aves. About $125,000.

Ill., Martinsville—The city plans to build a 60,000 gal. water tower, pumping station and lay distributing mains. About $94,000. W. R. Paige, Rose Dispensary Bldg., Terre Haute, Engr.

Ill., St. Anne—The Chicago Catholic Diocese, 740 Cass St., is having plans prepared for a 4 story academy here including a steam heating system. About $125,000. J. T. Fortin, 600 Blue Island Ave., Chicago, Archt.

Wis., Eagle River—The Bd. Educ. is having plans prepared for a 2 story high school. About $130,000. Parkinson & Dockendorff, Linker Bldg., La Crosse, Archts.

Wis., Two Rivers — The Bd. Educ. will soon award the contract for a 3 story, 180 x 190 ft. high school and boiler house. About $400,000. J. D. Chubb, 109 North Dearborn St., Chicago, Archt.

Wis., Waukeska—Waukeska County, c/o C. J. Hahn, highway Comr., will soon receive bids for furnishing tarvia heating apparatus and also a gasoline storage tank.

Wis., Whitehall — Trempealeau County, c/o J. Dewey, will receive bids until March 11 for a 40 x 70 ft. power house. About $15,000. A. D. Conoven, Tenney Blk., Madison, Archt. and Engr.

Ia., Cedar Rapids—Penick-Ford Ltd., c/o A. W. H. Lenders, Genl. Mgr., is having plans prepared for a 6 story factory including a steam heating system between 1st St. and River and 8th and 13th Aves. About $700,000.

Ia., Gowrie—The Bd. Educ. is having plans prepared for a 3 story school. About $155,000. Keffer & Jones, 301 Hubbell Bldg., Des Moines, Archts.

Ia., Lytton — The Bd. Educ. is having plans prepared for a 3 story, 64 x 135 ft. school. About $150,000. Keffer & Jones, 301 Hubbell Bldg., Des Moines, Archts.

Ia., Sioux City—The Y. W. C. A., c/o Mary H. Watson, Genl. Secy., Motor Mart Bldg, had plans prepared for a 3 story Y. W. C. A. building including a steam heating system on 6th and Jackson Sts. About $200,000.

Minn., Minneapolis — The Dunwoody Industrial Institute, 816 Superior Blvd., plans to build a 1 story, 325 x 400 ft. auditorium including a steam heating system on Superior Ave. About $250,000. C. A. Prosser, Dir. Architect not selected.

Minn., St. Cloud — Stearns County, c/o Nicholas Thomey, Co. Aud., will receive bids until March 17, for a 4 story, 100 x 140 ft. court house including a steam heating system. About $800,000. Toltz, King & Day, 1410 Pioneer Bldg., St. Paul, Minn., Archts.

Kan., Colby — The town voted $60,000 bonds to improve the electric light plant. Equipment will be installed, which will include two 175 to 200 hp. simple non-condensing Corliss type engines, direct connected to 2,300 volt, 3 phase, 60 cycle generators with complete boiler room accessories, feed water heaters, motor driven boiler feed pumps, motor driven deep well pump, etc. C. E. Reid, Manhattan, Engr.

Kan., Pittsburg — The Trustees of the Labor Hospital are having plans prepared for a 3 story hospital including a steam heating system. About $250,000. R. K. Crain, Secy. Architect not selected.

Kan., Wilsey—The town is issuing $18,000 worth of bonds for an electric light system here. C. E. Reid, Manhattan, Engr.

Mo., Hardin—The city plans an election to be held March 8 to vote on $30,000 bonds for a 100 gal. triplex pump, 35,000 gal. tank, etc. Rollins Eng. Co., Ry. Exch. Bldg., Kansas City, Mo, Engrs.

Mo., Mexico—J. T. Hoxsey is having plans prepared for a 5 story, 42 x 106 ft. hotel addition. About $150,000. B. C. Elliott, Mexico, Mo., Archt.

Okla., Mountain View—The city is having plans prepared for a steam power plant. About $30,000. V. V. Long & Co., 605 W. D. Capitol Hill, Oklahoma City, Engr.

Wash., Seattle—The Seattle School Dist., Central Bldg., had plans prepared for a 3 story, 216 x 337 ft. school on 15th and East 66th Sts. About $1,125,000. F. A. Naramore, Archt.

Cal., Covina—The City is having plans prepared for school buildings including an auditorium, 2 story science building and a 1 story manual training building. About $350,000. J. C. Austin, 1125 Baker Detwiller Bldg., Los Angeles, Archt.

Cal., Fullerton—The city will soon award the contract for furnishing and installing pumping equipment including 2 centrifugal or turbine pumps, capacity 900 gal. per min., two 100 hp., 3 phase, 50 cycle, 440 volt motors, 2 deep well turbine pumps capacity 900 gal., two 40 hp., 50 cycle, 440 volt, 3 phase motors.

Cal., Long Beach—H. C. Wanghope, City Clk., will receive bids from March 11 to 21 for a 7 story city hall on Bway. and Pacific Ave. About $400,000. W. H. Austin, 1st Natl. Bank Bldg., Archt.

Cal, Venice—The Bd. of Trustees plans to build school buildings here. About $250,000. E. Bergstrom, 1129 City Bank Bldg., Los Angeles, Archt.

N. B. Sackville — The Governors of Mt. Allison University plan to build additions. About $200,000.

B. C., Vancouver—The Canadian Exhibitors Exch., 553 Granville St., plans to build a 3 story, 75 x 120 ft. moving picture theatre on Granville St. to cost $200,000; and a 3 story, 100 x 120 ft. moving picture theatre on Hastings St., to cost $300,000. E. Sproat, 403 Dominion Bldg., Archt.

Ont., Galt—The Hydro Electric Comn. plans to build a 2 story hydro-electric substation. Transformers, etc. will be installed in same. About $35,000. W. F. Fauchild, Archt.

Ont., St. Catharines — The Peninsular Hotel & Amusement Co. plans to build a 1 and 2 story theatre including a steam heating and mechanical ventilation system. About $125,000. Architect not selected.

CONTRACTS AWARDED

Mass., Boston—The city, 1009 City Hall has awarded the contract for a 3 story, 150 x 213 ft. Latin school on Fenway Ave., to George A. Fuller Co., 710 Bd. Trade Bldg., at $774,800.

N. Y., Buffalo—The Bd. Educ., c/o James Storer, 1401 Telephone Bldg., has awarded the contract for two 2 story schools No. 1 and No. 9, to the Fenbusch Parker Constr. Co., Union Bldg., Cleveland, O. About $750,000.

N. Y., Elmira—The Steele Memorial Library, East Market and Lake Sts, has awarded the contract for a 2 story, 50 x 80 ft. library on Lake and East Church Sts., to the Lowman Constr. Co., 312 Railroad Ave., at $150,000.

N. Y., Long Island City—The Bd. Educ., 500 Park Ave., New York City, has awarded the contract for a school on Curtis Ave. and 124th St., to the Putnam Constr. Co., 303 5th Ave., New York City, at $257,872.

N. Y., New York—The Crimson Realty Co., c/o G. F. Pelham, Archt. and Engr., 200 West 72nd St., will build a 6 story, 70 x 200 ft. apartment house including a steam heating system on Riverside Drive and 152d St. About $250,000. Work will be done by day labor.

N. Y., Tarrytown — M. Goldblatt Music Hall will build a 3 story, 80 x 150 ft. theatre including a steam heating system on Bway. and Main St. About $200,000. Work will be done by day labor.

N. Y., New York—S. Golding, c/o G. and E. Blum, Archts. and Engrs., 505 5th Ave., will build a 6 story, 100 x 135 ft apartment house including a steam heating system on Ft. Washington Ave. near 170th St. About $750,000. Work will be done by day labor.

N. Y., New York—G. F. Johnson Estate, 30 East 42nd St., will build a 6 story, 90 x 100 ft. apartment house including a steam heating system on Southern Blvd. near Longwood Ave. About $180,000. Work will be done by day labor.

N. Y., New York—W. E. Lambert, 112 East 35th St., has awarded the contract for a 6 story, 40 x 100 ft. store and loft building including a steam heating system at 45 West 38th St., to the M. Cohen Constr. Co., 110 West 40th St., at $150,000.

Ind., Marion—The Natl. Military Home has awarded the contract for a 3 story barrack building, here, to H. R. Blagg Co., 1229 East 3rd St., Dayton, O., at $205,000.

Minn., Marble—The village has awarded the contract for a 2 story, 80 x 120 ft. village hall including a steam heating system, to Hugh Fawcett, 31 Mesabe Blk., Duluth, at $106,587.

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